THURSDAY, MAY 8, 1902.

STONEHENGE.

The Wiltshire Archaeological and Natural History Magazine. Stonehenge and its Barrows. By William Long, M.A., F.S.A. Pp. 244; many illustrations. (1876.) Price 7*s.* 6*d.*

The Wiltshire Archaeological and Natural History Magazine. Stonehenge Bibliography Number. By W. Jerome Harrison. Pp. 170 (1902.) Price 5*s.* 6*d.*

THE Wiltshire Archæological and Natural History Society is to be warmly congratulated on its persistent and admirable efforts to do all in its power to enable the whole nation to learn about the venerable monuments of antiquity which it has practically taken under its scientific charge.

Chief among these, of course, is Stonehenge, and it is fortunate for students that while interest in this structure, unique in so many particulars, is being revived, such a rich mine of information as that supplied by the Wiltshire Society should be available.

It is within the knowledge of all interested in archæology that not long ago Sir Edmund Antrobus, the owner of Stonehenge, at the request of this famous local society, the Society for the Protection of Ancient Buildings and the Society of Antiquaries, enclosed the monument in order to preserve it from further wanton destruction, and with the skilled assistance of Messrs. Carruthers and Detmar Blow set upright the most important menhir, which threatened to fall or else break off at one of the cracks.

Ever since that time he has been the butt of agitations in the local parish councils, got up apparently by persons who care, not for the preservation of ancient monuments, but rather that there shall be no right of property in anything interesting enough to be worth chipping.

The "unclimbable wire fence" recommended by the societies in question, the Bishop of Bristol being the president of the Wiltshire Society at the time, is by them regarded as a suggestion that the property is not national, the fact being that the nation has not bought the property and that it has been private property for centuries.

It is curious to think that the very destruction of the monument is now urged as an argument against enclosure. The *Times* in a recent article tells us some of the arguments used before a Committee of the County Council.

"There are old ways, long and systematically used, which lead directly to the stone circles, and the barbed wire stretches right across these ways. One fact alone is sufficient to prove their antiquity. The outermost circle of Stonehenge consists of an earth vallum worn down by time and weather, but still rising some feet above the natural surface of the ground. The ways in question cut through this vallum, which rises abruptly some three feet or so on either side of them."

Everybody except the devastators knows that this vallum is the equivalent of the temenos walls which surround the Egyptian temples, and is part and parcel of the temple.

It is very sad to read, both in Mr. Long's volume and the bibliography, of the devastation which has been allowed to go on for so many years and of the various forms it has taken. It appears that this temenos wall or vallum was the first to suffer by indiscriminate driving over it, so that its original importance has now become so obliterated that many do not notice it as part of the structure; and that it bears the same relation to the interior stone circle as the nave of St. Paul's does to the Lady Chapel.

It appears also, from the *Times* account of the meeting, that a recent paper by Mr. Penrose and myself on the orientation of Stonehenge may have added strength to one of the arguments so improperly employed and apparently endorsed by Mr. Shaw Lefevre and others:—

"One fact of singular interest was elicited. There seems to have been a special gathering every year, numbering thousands of persons, at Stonehenge to witness the rising of the sun on the 21st of June. As Stonehenge, according to the best opinions, was originally constructed with reference to rites performed at this very moment, there is nothing extravagant in the supposition that there has been something in the nature of a public assembly on Salisbury Plain at midsummer ever since the circles of Stonehenge were first completed."

Meanwhile we trust the Wiltshire Society will continue its labours, which date back at least to 1866, for the preservation of the monument, and that the members of the various Councils concerned will read the literature the Society has printed and become less philistine in their attitude. If Stonehenge had been built in Italy or France or Germany, it would have been in charge of the State long ago. Let the County Council send a small committee to Carnac to see how the equivalent monuments are looked after there.

It is very sad that in this twentieth century there should be Englishmen philistine enough to wish to preserve a so-called "right of way" which cuts through the vallum twice and passes close by the most important and imposing stone circle in the world. It is still sadder that since Sir Edmund Antrobus, the present owner, has accepted the advice of the Societies I have named to enclose the monument, with a view to guard it from destruction and desecration, he has been assailed on all sides, as we have seen. The world of science has already one matter of the highest importance to thank him for, namely, the setting upright of the so-called leaning stone, which was tottering to its fall. Let us hope that before long the minor gaps in the vallum may also be filled up. When they are, the present upholders of the "right of way" through the major ones will be the first to insist that the road shall be deviated outside one of the most imposing monuments of the world. In the meantime, it is comforting to know that, thanks to what Sir Edmund Antrobus has done, no more stones will be stolen, or broken by sledge-hammers; that fires; that unskilled excavations such as were apparently the prime cause of the disastrous fall of one of the majestic trilithons in 1797; that litter, broken bottles and the like with which too many British sightseers mark their progress, besides much indecent desecration, are things of the past.

Let me now refer more particularly to the publications of the Wiltshire Society bearing on Stonehenge.

Dealing with Mr. Long's memoir first, it may be stated that it includes important extracts from notices of Stonehenge from the time of Henry of Huntingdon to Hoare (1812), and that all extant information was given touching on the questions by whom the stones were erected, whence they came and what was the object of the structure. The barrows on Salisbury Plain are next carefully described, and the information to be obtained from them discussed in a most masterly way. It is a very great pity that a book so full of facts of great interest along so many lines has no general index.

Many who have followed the recent work on the monuments will be glad to have beside them for ready reference so many extracts from the publications of those who have attempted to solve its mysteries in the past. Thus we learn (p. 44) that in 1771 Dr. John Smith, in a work entitled "Choir Gawr, the Grand Orrery of the Ancient Druids, called Stonehenge, Astronomically Explained, and proved to be a Temple for Observing the Motions of the Heavenly Bodies," wrote as follows :—

"From many and repeated visits I conceived it to be an astronomical temple ; and from what I could recollect to have read of it, no author had as yet investigated its uses. Without an instrument or any assistance whatever, but White's 'Ephemeris,' I began my survey. I suspected the stone called *The Friar's Heel* to be the index that would disclose the uses of this structure ; nor was I deceived. This stone stands in a right line with the centre of the temple, pointing to the north-east. I first drew a circle round the vallum of the ditch and divided it into 360 equal parts ; and then a right line through the body of the temple to the Friar's Heel ; at the intersection of these lines I reckoned the sun's greatest amplitude at the summer solstice, in this latitude, to be about 60 degrees, and fixed the eastern points accordingly. Pursuing this plan, I soon discovered the uses of all the detached stones, as well as those that formed the body of the temple."

With regard to this "Choir Gawr," translated Chorea Gigantum, Leland's opinion is quoted (p. 51) that we should read Choir vawr, the equivalent of which is Chorea nobilis or magna.

That the slaughter stone was once upright is rendered probable by a reference to Mr. Cunnington's digging in 1803 (p. 56). Mr. Long adds :—

"Mr. William Cunnington, F.G.S., informs the writer that if this stone *stood erect*, it must have entirely concealed the 'gnomon' from persons standing in front of the 'altar.' 'It would have been impossible,' he says, 'to see the sun rise over the "gnomon" from the exact centre of the building. It is nevertheless a fact that the gnomon *does* occupy this critical position, as to the sunrise at the solstice.'"

But as we now know that from the axis of the sarsen stones the sun did *not* rise over the "gnomon," that is the Friar's Heel, this reasoning is not conclusive.

Again, there is the question of the roof. In our paper communicated to the Royal Society, Mr. Penrose and myself gave reasons why the Naos, that is the space included in the horseshoe of trilithons, was covered. This suggestion, however, I now find is not new, the view having been held by no less an authority than Dr. Thurnham (p. 67), who apparently was led to it by the representations of the Scandinavian temples as covered and enclosed structures.

On pp. 71 *et sqq.* I find a very interesting extract from a paper by Mr. Cunnington on the "Geology of Stonehenge." He points out the origin of the sarsens according to Prestwich :—

"Among the *Lower Tertiaries* (the Eocene of Sir Charles Lyell), are certain sands and mottled clays, named by Mr. Prestwich the Woolwich and Reading beds, from their being largely developed at these places, and from these he proves the sarsens to have been derived ; although they are seldom found *in situ*, owing to the destruction of the stratum to which they belonged. They are large *masses of sand concreted together* by a silicious cement, and when the looser portions of the stratum were washed away, the blocks of sandy rocks were left scattered over the surface of the ground.

"At Standen, near Hungerford, large masses of sarsen are found, consisting almost *entirely* of flints, formed into conglomerate with the sand. Flints are also common in some of the large stones forming the ancient temple of Avebury.

"The abundance of these remains, especially in some of the valleys of North Wilts, is very remarkable. Few persons who have not seen them can form an adequate idea of the extraordinary scene presented to the eye of the spectator, who standing on the brow of one of the hills near Clatford, sees stretching for miles before him, countless numbers of these enormous stones, occupying the middle of the valley, and winding like a mighty stream towards the south."

Mr. Cunnington displayed great acumen in dealing with the smaller stones not sarsens.

"The most important consideration connected with the smaller stones, and one which in its archæological bearing has been too much overlooked, is the fact of their having been brought from a great distance. I expressed an opinion on this subject in a lecture delivered at Devizes more than eighteen years ago, and I have been increasingly impressed with it since. I believe that these stones would not have been brought from such a distance to a spot where an abundance of building stones equally suitable in every respect already existed, unless some special or religious value had been attached to them. This goes far to prove that Stonehenge was *originally a temple*, and neither a *monument* raised to the memory of the dead, nor an astronomical calendar or almanac.

"It has been suggested that they were Danams, or the offerings of successive votaries. Would there in such case have been such uniformity of design or would they have been all alike of foreign materials? I would make one remark about the small impost of a trilithon of syenite, now lying prostrate within the circle. One writer has followed another in taking it for granted that there must have been a second, corresponding with it, on the opposite side. Of this there is neither proof nor record, not a trace of one having been seen by *any* person who has written on the subject. This small impost, not being of sarsen, but syenite, must have belonged to the original old circle ; it may even have suggested to the builders of the present Stonehenge the idea of the large imposts and trilithons, with their tenons and mortices."

There are several references throughout Mr. Long's memoir to the tradition of the slaughter of Britons by the Saxons at Stonehenge, known as "The Treachery of the Long Knives" ; according to some accounts, 460 British chieftains were killed while attending a banquet and conference. But one important item is omitted. I have gathered from Guest's "Mabinogion," vol. ii. p. 433, and Davies' "Mythology of the British Druids," p. 333, that the banquet took place on May eve "Meinvethydd."

There is ample astronomical evidence that arrangements were made for observing the sun on May day both before and after the erection of the sarsens, and I think by this the truth of the tradition is strengthened.

Of the more recently published volume dealing with the bibliography of Stonehenge it may be said that no reference to Stonehenge by any ancient author, or any letter to the *Times* for the last twenty years dealing with any question touching the monuments, seems to be omitted from the bibliography. Thus, to give an instance, I find my old friend Sir Arthur Helps' work on "Spain's Conquest of America" referred to because in vol. iii. he treated of sun worship in Peru. The bibliography is not only to be commended for its thoroughness, but for its admirable method; it is a model of what such a work should be, and has evidently been a labour of love: Mr. Harrison acknowledges his obligations to the Birmingham Free Reference Library and the Bodleian, as well as to the Society's library at Devizes. NORMAN LOCKYER.

STUDIES IN THE DISTRIBUTION OF PLANTS.

Die Vegetation der Erde, Sammlung pflanzengeographischer Monographien. Herausgegeben von A. Engler und O. Drude. (Leipzig: Verlag von W. Engelmann.)

1. *Grundzüge der Pflanzenverbreitung auf d. iberische Halbinsel.* Von Moritz Willkomm. Mit 21 Textfiguren, 2 Helio und 2 Karten (1896.)
2. *Grundzüge d. Pflanzenverbreit. i. d. Karpathen.* Von F. Pax. Mit 9 Textfiguren, 3 Helio und 1 Karte (1898.)
3. *Grundzüge d. Pflanzenverbreit. i. d. Kaukasusländern, von der unteren Wolga ueb. d. Manytsch-Schneider, bis z. Scheitelfläche Hocharmeniens.* Von Dr. Gustav Radde. Mit 13 Textfiguren, 7 Helio und 3 Karten (1899.)
4. *Die Vegetationsverhältnisse d. Illyrischen Länder.* Von Dr. Günther ritter Beck v. Mannagetta. Mit 6 Vollbildern, 18 Textfiguren und 2 Karten (1901.)
5. *Die Heide Norddeutschlands.* Von P. Graebner. Mit einer Karte (1901.)

THE editors of the series of which the five volumes before us form the first instalment are to be congratulated no less on the courage with which they have embarked on a vast undertaking than on the success which has thus far attended their labours. The authors who have been severally entrusted with the floras of the different regions have been wisely selected, and are well qualified by special knowledge, extending in some cases over a considerable number of years, to grapple successfully with a task of no small difficulty and one which calls for the exercise of critical judgment of no mean order.

The general method of treatment is, in its broader outlines, tolerably uniform throughout the series, though of course there is considerable diversity in the treatment of details. A brief historical introduction in each case gives an account of the previous work done in a particular region, and this is followed by a discussion of the physical characters and climate of the latter, in so far as these affect the nature of the vegetation and the distribution of the plants within the area. The floras themselves, though often containing rather lengthy lists of plants, are designed, in the first place, to give the reader a general picture of the vegetation as a whole, and also to enable him to trace its relations with the physical environment. For this purpose they are broken up into groups, characterised by the predominance of some particular tribe or assemblage of plants, *e.g.* the oak flora, the Mediterranean, the alpine, &c. In some cases, too, the cultivated plants are sufficiently described to give a fair impression of the chief features of the more inhabited regions. Perhaps the most generally interesting part of each book is that which deals with the affinities of the flora with the plants of foreign countries, and also the ecological peculiarities that are illustrated within the area of the several regions themselves.

The flora of Spain is discussed by Dr. Willkomm. It is one which is full of interest, not only from the large number of endemic species which it includes, but also for the great variety of *facies* which it exhibits. These characters are clearly traced in connection with the isolation, in the first place, of the peninsula itself, and, secondly, in the remarkable diversity of physical conditions which prevail within it.

The Carpathian flora, discussed by Prof. Pax, is one of remarkably mixed origin, but its affinities can be traced pretty definitely to a European source, on the one hand, and an Asiatic one on the other. Several forms from Siberia find a place here, but the greater number come from Asia Minor and do not extend farther into Europe. There is, of course, a fairly strong affinity with the flora of the Alps, whilst a Pyrenean element is also met with. The flora is thus rather a synthetic one, although there are a few endemic forms. The latter are, however, related to others occurring in the regions above named. In dealing with the flora of the lower slopes, the author deplores the mischievous effects of an imperfect acquaintance with the principles of forestry upon the woodlands, many of which are apparently suffering severely from ignorant treatment.

The volume is one which will appeal strongly to anyone who, is interested in the broader problems of distribution and ecology, and it is a solid as well as a suggestive contribution to scientific literature.

Prof. Radde, in dealing with the plants of the Caucasus, describes the vegetation of the steppes to the north of the range, and his frequent journeys into these regions enable him to give a very fair impression of the appearance of these lands at different seasons of the year. The character of the vegetation of the higher altitudes of the Caucasus differs greatly on the two slopes, as might have been expected from the general trend of the mountains themselves. On the southern slope there is a great predominance of Persian plants, as shown by the abundance of species of Astragalus, Acantholimon and others. The prevailing character of the flora is markedly xerophytic, and it should be one which would repay further biological investigation.

The author distinguishes five principal zones, viz. the

steppes, woods, subalpine, alpine and high-alpine respectively, and these main subdivisions are broken up into smaller groups which exhibit some definite character by which they can be distinguished. A somewhat curious feature of the book rests in the inclusion of an account of the principal insect pests which are injurious to the cultivated plants.

The Illyrian flora, as described by Dr. Günther ritter Beck v. Mannagetta, is one which seems to be a promising, if difficult, field of exploration. The plants of the maritime regions are, for the most part, an extension of the typical Mediterranean vegetation; but in the higher levels, where the minimum temperature sinks below 14° C., it is succeeded by one of which the oaks form the characteristic feature. The swamp plants which occur in this zone consist, for the most part, of northern European forms, mixed with others of wide distribution. Still higher, the willows and pines form the distinctive land-marks, and these are finally succeeded by an alpine flora which varies in character in the different mountain groups. This is due largely to difference in geological character, and partly also to the isolation of the mountains themselves. The volume includes a short sketch of the Algæ of the Adriatic coast, and ends with a discussion as to the relationships of the Illyrian flora with that of the surrounding countries, especially with regard to the physical changes which have occurred since Tertiary times.

The last, but by no means the least interesting, volume, by Dr. Graebner, deals with a more restricted formation, but this very circumstance affords an opportunity for a more detailed treatment. The heath and moorland vegetation is one which fairly bristles with interesting problems, and the volume in question forms a useful contribution to the whole subject. Here and there, perhaps, the chemical aspects of the relation between plant and soil preponderate over the hardly less important biological ones. The author corrects a common error as to the relation between the heather and a limestone soil. He shows that the destruction of the heather, or its non-appearance, is not due to the presence of the calcium salts directly, for he proves by experiment that in a sufficiently poor soil lime may be added in quantity without any injury to the plants in question. But a natural limestone soil is commonly also rich in other mineral constituents which are available for food manufacture, and it is to the presence of these that its absence or extermination is due. Heather is, in fact, very sensitive to manure, which causes its disappearance from soils which may have been previously infested by it.

It is, of course, quite impossible to do justice to the books under consideration within the limits of a short notice such as the present, but it is hoped that enough has been said to indicate their importance in helping to fill a serious gap in botanical literature.

It may be fairly said, moreover, that each volume will be quite indispensable to anybody who may desire to make a close acquaintance with the scientific aspects of the floras of the regions thus severally dealt with. And, taken collectively, they render it possible to acquire a far more intelligent grasp of the facts, and therefore also of the problems, of plant distribution and ecology than has hitherto been practicable for most of us.

OUR BOOK SHELF.

La Question de l'Eau potable devant les Municipalités. By P. Guichard. Pp. 190. "Encyclopédie Scientifique des Aide-Mémoire." (Paris: Gauthier-Villars, n.d.) Price fr. 3.

IN this work the author has brought together accounts of the water supplies of some twenty-six towns of France, giving details, as far as possible, of the source from which the water is derived in each case, of the treatment to which it is subjected before distribution and of its chemical and bacteriological character. These accounts are derived from analyses and reports furnished by the various analysts who have actually examined the supplies, and are of very varying degrees of completeness. The object which the author had in view in making his inquiries was to ascertain what method of purification, if any, was usually employed by the municipality to ensure the freedom of the water from the germs of disease. The answer to this question is that the municipalities select the best water at their disposal and deliver it to the consumers either without any treatment or after filtration through sand, Anderson's iron process being used in a few cases. The author does not regard sand-filtration as by any means a satisfactory method of purification, in spite of the fact that experiments have shown that when properly carried out it is extremely efficacious, and that the comparative freedom from water-borne disease of towns like London, which make use of water known to be polluted, depends entirely on its use. No discussion of this or kindred points is given, and this somewhat detracts from the value of the book. After pointing out the numerous sources of contamination which may affect the water of towns both before collection and during distribution, the author recommends all householders to protect themselves by purifying all water in their own houses by filtration or other means, and believes that only in this way can security be attained. A very proper and timely protest is made against the continued use of cemeteries for burying those who have died of infectious diseases, and also against the fashionable institution of cemeteries for pet animals, the infiltrations from all of which pass into the streams and rivers of the district, so that, as the author expresses it, "nous mangeons ou buvons de l'homme et du chien à une sauce non prévue dans les traités de gastronomie."

Plissements et Dislocations de l'écorce terrestre en Grèce By Ph. Negris. Pp. 210; 2 maps. (Athens: C. Beck; Paris: C. Béranger, 1901.)

THE large questions raised by the author cannot be adequately discussed in a brief notice, so it must suffice to state his main facts and inferences, expressing doubts in passing. Since Jurassic times, successive earth-movements have affected Greece and the adjacent parts of Turkey. The foldings produced are distinguished by local names. The earliest, or Olympic, which is pre-Cretaceous, runs from N.W. to S.E. along the eastern coast and a chain of islands as far as Karpalho. The Pentelic, closing that period, is at right-angles to it and acts more especially on the Ægean area, its western coasts and the Morea. The Achaic, which occurred during the Eocene, more or less affects the whole region and even Crete, running W.N.W. to E.S.E. The Pindic, closing the Eocene, trends in a N.N.W.–S.S.E. direction and can be traced in the Pindus mountains, the country to the west and the Morea. Last is the Tenarus folding, which began late in the Pliocene and affected the whole of the Greek kingdom, running from N. to S. All are generally associated with outbursts of igneous rock—peridotite (serpentine) in the earlier, trachyte in the later. There are also three important sets of faults, on which, however, we cannot dwell. The Tenarus folding pro-

duces the most important effects, for the author regards it as only a part of a great series of disturbances which modified the earth's crust as far away as the American continent. These are mainly responsible for the Glacial epoch, and the advance or retreat of the ice and the variations in sea-level must be attributed to earth-movements during it. Often, he insists, the sea, rather than the land, has altered its level, owing to changes in the form of the ocean basins. No doubt this is true, but we think the author presses it too far. He has also such faith in land-ice as to introduce the Scandinavian ice-sheet to the Shetland Isles, without caring to explain how it got across the deep valley which contours the southern and western coast of Norway. The earth-movements already mentioned were sometimes rapid, and the author connects the later of them with traditional deluges. The fabled Atlantis is Brazil, which had been converted into an insular tract by a rise of the sea. All this is certainly ingenious, though it may be unconvincing. He also gives us an explanation of the curious "bone beds" of Pikermi. Downward movements (connected with the second set of faults) submerged the lowlands. The animals fled for refuge to the hills, where they were killed *en masse* by mephitic vapours, which, fortunately for geologists, were exhaled in the nick of time, and their dead bodies were afterwards carried lower down by floods and mudstreams. *Credat Judæus!*

Last Words on Materialism. By L. Büchner. Translated by J. McCabe. Pp. xxxiv + 299. (London: Watts and Co., 1901.) Price 6*s.* net.

IT can scarcely have been the intrinsic worth of these occasional essays which induced the "Rationalist Press Association" to circulate them in an English dress. The volume is marked by all the confident dogmatism and loose reasoning for which the author of "Force and Matter" is unfavourably known to serious students. Its value as a contribution to genuine thought on the ultimate constitution of the world around is of the slightest. The author's position is that thought and will are secondary derivatives of a reality which is, in its own nature, "material" in the sense of being not mental, but for this position no proof whatever is offered. The "idealist," who comes in for a good deal of abuse which, from an English point of view, must be pronounced decidedly undignified, is never fairly met. His real argument, that the physical world itself is only given us in terms of the experiences of a sentient perceiver, is quietly ignored, and he is only allowed to make the futile objection that he does not know by what special process physical energy is "transformed" into consciousness. The writer's competence in philosophic discussion is shown by the fact that he thinks the inability of savages to count beyond four a proof that mathematical science is purely empirical. Similarly, he thinks Kant's view of the presence of an *a priori* element in knowledge refuted by the irrelevant appeal to the fact that knowledge has been acquired by a process of gradual development. The real point has, of course, nothing to do with the process by which we come to know; it is purely a question of how knowledge is constituted when you have got it. The excursions into philosophic history made in such essays as those on "Hobbes" and on "Buddhism and Christianity" are even sorrier stuff than the rest of the book. Büchner seems to have known little or nothing about the subject; he repeats complacently the absurd farrago by which Pythagoras has been brought into connection with Buddha, and expressly praises Hobbes for being—precisely what he was not—an empiricist. The "Rationalist Press Association" is doing scientific thought no good service in issuing such a mixture of anti-ecclesiastical rhetoric and crass metaphysical dogmatism as representing the views of serious science about the world.

A. E. T.

LETTERS TO THE EDITOR.

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The Misuse of Coal.

WHILE most thoroughly agreeing with Prof. Perry in his desire to see a more efficient use made of our coal-supply, I yet think that he has drawn far too gloomy a picture of the future, and I wish to draw attention to a consideration which does not seem to have been present in his mind, or to have occurred to any of those hitherto dealing with the question as either authors or inventors. Prof. Perry says that "scientific men know of no other store of energy available for man's use than fuel from the earth, except what we may get by the help of the tides or by the wind or waterfalls." With the exception of the tides, the energy of all these sources is derived ultimately, as is also that of coal itself, from the heat radiated by the sun, and what I wish to point out is that the heat of the sun may be made to furnish power in quite another way—a way, in fact, indicated by Nature herself.

Prof. Perry points to animal organisms as types of efficient engines. Now, what is the fuel consumed by these engines? Obviously it is *vegetable matter* which derives its energy from the *solar radiation of the present day*. At the same time, it is evident that at the present moment only a small percentage of the solar radiation falling on the surface of the earth is used in this way; yet it will be found that the amount of energy derived from this source is very large compared with that provided by our coal-supply. The detailed calculation cannot be attempted here, but a few figures will serve to show the order of magnitude we are dealing with. Taking Prof. Perry's figure for a year's coal-consumption at 663 million tons, and taking the average efficiency of engines at 3 lb. of coal per horse-power hour—which is probably too high an efficiency—the figures work out to an annual output of 495,000 million horse-power hours, and this is roughly equivalent to 56 million horse-power working continuously night and day. Considering the number of human beings, horses, cattle and sheep, and considering their output in heat as well as in mechanical work, it is evident that the energy supplied by food—however efficiently used—must be vastly greater than that given by our present coal-consumption. Here, then, is an enormous source of energy only partially tapped at present—the heat radiated to the earth by the sun—and the method of using it is indicated by Nature. When our stock of fuel approaches exhaustion, we shall—so it appears to me—have to set to work and—to put it crudely—grow our own fuel as we go along.

The use of vegetable matter for fuel is by no means unknown even to-day; for although wood has long ceased to compete with coal as a fuel, yet in Germany at the present time a new industry is growing up in the production of crude spirit from potatoes. This spirit is used as a *cheap fuel* in internal-combustion motors, and is therefore evidently able to compete with earth-fuels even in a northern country where solar radiation is not very intense and land-values are high. The progress from the use of wood and charcoal as a fuel to the use of potato-spirit is so great that we may reasonably expect much more in the same direction when once attention has been concentrated upon the matter. In fact, it may not be too much to expect that ultimately the regeneration of carbon from the dioxide of the atmosphere may be accomplished by means of synthetically prepared bodies which—somewhat like the chlorophyll of the living plant—are capable of decomposing carbon dioxide under the influence of sunlight. In those circumstances, the solar heat used in the evaporation essential to the growth of plants might be saved for the direct production of fuel, and the yield per acre of sunlit area greatly increased. I think, therefore, that in "fuel farming," in the first instance by the most prolific plants available, and ultimately by purely chemical agents, the problem of the supply of energy after the exhaustion of the world's coal-supply may perhaps be solved. All I am here trying to show is that the quantity of energy available by these means is large compared with the power actually in use at the present day, and even this I have only indicated in the roughest way; but I agree with Prof. Perry as to the extreme importance of the question, and I think with him that it is a matter of vital national importance. If, however, fuel farming is really a

possibility of the future, then perhaps Prof. Perry's gloomy picture of the decay of Great Britain may be falsified. The place of our coal-mines in our national assets would then be taken by the vast areas of sunlit land in our Colonial Empire, for fuel-production would then become a question of the number of acre-hours of sunlight available.

I should like to add that what I have said in this letter does not at all lessen the urgency of Prof. Perry's plea for efficient engines; in fact, I think that what I have pointed out tends to strengthen the demand for a great national effort at the solution of these pressing problems. At present we are, in matters of energy, "robbing posterity" while it is eminently desirable that we should discover a way—if there be one—of "paying our way," and I think that in fuel farming such a way may perhaps be found. WALTER ROSENHAIN.

443 Gillott Road, Edgbaston, April 27.

MR. ROSENHAIN is mistaken as to the ignorance of inventors; many engines have been invented and referred to in newspapers during the last thirty years for utilising solar heat. I may remark that such heat engines may be very efficient, because the available temperature may be very high indeed. I have sometimes wondered why metallurgists neglected the possibility of obtaining very high temperature furnaces from the heat of the sun. As to the energy available, at p. 14 of my book on "Steam" I say:—"On one square foot of Egypt the heat energy received in one year from the sun is about 10^9 foot pounds, or 500 horse-power hours." This is nearly equivalent to the energy of a coating of coal all over Egypt one foot thick, and promises a future for the Sahara and other cloudless regions of the earth. I therefore admit that I did not give sufficient weight to this consideration of the direct heat from the sun, and I am very glad that Mr. Rosenhain has drawn attention to my neglect.

J. PERRY.

Experimental Mathematics.

PROF. PERRY'S syllabus in practical mathematics has now been published two or three years, and the results of actual experience of its working may have some interest. We have in this institute about three hundred students of mathematics, including boys in the day school as well as older evening students, who follow a course on the lines of Prof. Perry's syllabus, and in both classes the adoption of the method has aroused an increased interest in the subject. This increase of interest seems to be due to the fact that the method is essentially experimental as well as deductive. Mathematics is treated as a science rather than, according to a common tradition, as an "arts" subject. The student is taught to investigate the facts for himself by experiment in the form of actual plotting and measurement and numerical calculation, just as in the study of such a science as electricity he investigates a law for himself in the laboratory and, usually at a later stage, proves in his theoretical work that that law follows from his previous knowledge. This is not merely a question of illustrating elementary geometry, but the practice may be carried with advantage into what are usually considered quite advanced parts of his work. However well a student may know the analytical proofs involved, he greatly improves the firmness of his grasp by actually plotting, with various numerical values of the constants, curves to represent such a case, for instance, as the small oscillations of a stiff spring, or the form of a bent beam. In pure mathematics, especially in differential geometry, many examples may be found, and, in fact, the method of conformal representation, which has been so fruitful in the theory of functions and its applications, is really an instance of this method. Besides increasing the average student's interest in his work, these "direct vision" methods, used systematically throughout a student's course, give more solidity and a clearer definition to his ideas than it seems possible to attain by abstract reasoning alone.

My special object, however, in writing is to insist on the value of the method as a logical training. We sometimes hear of the "invaluable logical training" of Euclid with the implied assumption that other methods of treating mathematics are illogical. This view seems to ignore the fact that there is an inductive as well as a deductive logic. If a boy is taught from the beginning to verify all theorems by actual plotting and measurement, he trains, not only his logical powers of deductive reasoning in proving his theorem from its premises, but also his equally logical powers of inductive reasoning from observation and experiment. From the point of view of educational theory this seems a sounder method than to restrict his training to one form of logical reasoning to the neglect of the other. The deductive logic of the syllogism was the only form known in the time of Euclid, but it is scarcely necessary to say that inductive logic now holds a recognised place, and the whole development of modern experimental science has proceeded by its methods.

John Stuart Mill, as is well known, devotes a very scanty consideration to syllogistic reasoning on the ground that "Formal Logic therefore, which . . . have represented as the whole of logic properly so called, is really a very subordinate part of it, not being directly concerned with the process of Reasoning or Inference in the sense in which that process is a part of the Investigation of Truth," and that "The foundation of all sciences, even demonstrative or deductive sciences, is induction."

This may, perhaps, be the explanation of the difficulty which so many boys as well as older students feel in comprehending demonstrative geometry. Most teachers of evening students have met with men of considerable ability and some maturity of mind who have little or no difficulty with algebraical work, but can never comprehend the meaning of a proposition in Euclid. The syllogistic method of reasoning seems to find no avenue into their minds, although they can reason well enough from observed facts. Such people are usually set aside as having no mathematical gift, but all must have notions of space and time, and consequently of change and a rate of change, and if rigid deductive methods were so essential as is often supposed to the science which puts those notions into scientific form, they would scarcely be incomprehensible to so many. If anyone has the power of comprehending the facts of a science such as chemistry, he must have some power of putting that knowledge into scientific form, and so anyone whose experience is given in space and time can scarcely be quite without the power of understanding the science which deals with those conditions of his experience. In fact, if students who seem to be without mathematical power are allowed to approach the subject by an experimental method, they find no difficulty in understanding it and may in time come to grasp the significance of deductive methods. In secondary schools of the classical and mathematical type, boys who are not on the science side are at present almost without the opportunity of developing their inductive logical powers, with the exception of the few who reach the stage where they can draw their own conclusions from the facts of philology or history. Experimental mathematics might in this case be made to supply the place of the missing experimental training.

However one may admire the symmetry of an ideal rigid body of mathematical knowledge, built up in the mind of the learner so that each step is made to depend by flawless abstract reasoning on what has gone before, and so on down to necessary axioms at the foundations, such a process cannot be carried out in the practice of education. It is sometimes said that a student should not be allowed to use any process or to believe any theorem until he can render a complete and perfect reason for it. But if a student is to follow such a method he should not be allowed to use $0\cdot\dot{3}$, until he can justify his use of it from a knowledge of the meaning of a limiting value and of the criteria for the convergency of series, nor may he use $\sqrt{2}$ as a number until he has mastered the modern theory of irrational numbers and made up his mind whether to hold opinion with Dedekind and Weierstrass, that the conception of an irrational number is to be based on a purely arithmetical theory, or with Du Bois-Reymond, that it is essentially geometrical and inseparably connected with linear magnitude. It is obvious that no teacher can attempt such a course; these difficulties are always passed over without proof.

In the method of practical mathematics, this practice is frankly recognised as legitimate and natural, and is systematically extended to other parts of mathematics.

Whatever may be true of the superstructure, the fundamental notions of pure mathematics have not been built up by strict deductive process, but by a series of successive approximations to the truth. The conception of a limiting value is a case in point. Until the time of Cauchy, the existence of a limiting value was thought to be self-evident on geometrical grounds in such a case as that of the area of a polygon inscribed in a circle. Cauchy in his treatment of definite integrals recognised that it was necessary to prove that a definite limiting value existed in such a case, but it was only in 1883 that a completely neces-

sary and sufficient criterion for the existence of a definite integral was supplied by Cantor and Dedekind.

Thus the great body of analysis had been built up long before the fundamental notion of a limit was completely established.

A somewhat similar course might be traced in the development of modern ideas as to the basis of mechanics.

In Prof. Perry's method, especially in teaching the calculus, it is recognised that this is the natural way to approach the subject, not only for the science as a whole, but in the mind of the individual student, and its foundations are soundly laid on direct geometrical intuition and the notion of a rate of increase, full analytical treatment being left to a much later stage.

This enables the calculus to be introduced at a much earlier stage than usual, and I may here quote the graphic advice of Prof. Burkhardt, all the more striking as it comes from a mathematician distinguished in pure mathematics:—"Dem angehenden Jünger der Mathematik würde ich raten, sogleich mit beiden Füssen in die Differential- und Integralrechnung zu springen." F. M. SAXELBY.

Royal Technical Institute, Salford.

Rearrangement of Euclid's Propositions.

I FEEL that Prof. Lodge's proposal to change the order of Euclid Book I., 1–32, is the real solution of the present problem of the teaching of elementary geometry. The budding engineer has his practical mathematics, the embryo wrangler will absorb geometrical truths served up in almost any manner; but the ninety per cent. to whom mathematics is a mere mental training must have their work put before them in an interesting, practical and yet logical manner. I should, however, like to put forward the following three points:—

(*a*) That Prof. Lodge's idea should be carried further, and Euclid, Books I.–VI., divided into four new books, as:—

The straight line	— Euclid I. 1–32 in some good order.
The circle	— Euclid III. 1–34, IV. 1–5 and escribed circles.
Areas	— Euclid I. 35–48, II., III. 35, 36, 37, IV. 6 to end.
Proportion	— Euclid V. and VI.

For Book I., I would suggest an order commencing with I. 32, cor. 2, which is the most general proposition for all rectilinear figures; and also that certain well-accepted riders should be added, many of which form more powerful instruments for solving geometrical problems than the majority of Euclid's propositions; that, in the circle, tangents should be treated as limiting chords; that, in areas, the "alternative" proofs of Euclid Book II. should be *the* proofs; finally, that proportion be done semi-algebraically, using fractional notation $\frac{AB}{CD}$.

(*b*) That it is not necessary—I may say, not advisable—to teach a beginner the words of a strict definition; but he should be given the idea alone, built up from practical use of a set of instruments, the verbal definition following when he is able to appreciate it. I would advocate that the following definitions be substituted for Euclid's unsatisfactory ones.

A straight line is one such that if any part be taken up and applied to any other part *in any manner*, so that its extremities fall on that part, it will coincide altogether.

The angle—the trigonometrical definition.

Parallel straight lines—the converse of axiom XII.

These would lead, for the student, to the ideas that a straight line can be drawn with a *ruler*, an angle drawn or measured with a *protractor*, and parallel straight lines drawn with two *set-squares*, one fixed and the other movable.

If these were accepted, I. 13, 14, 15, 27, 28, 29 follow almost axiomatically, and we are enabled to prove I. 32, cor. 2, by a supposititious construction, obviating such practical proofs as "walking round the sides" or Prof. Minchin's better idea of placing a pin along a side and moving it round, substituting a purely geometrical proof.

(*c*) That it is unreasonable to bar supposititious proof-constructions—*e.g.* in the bisector proof of I. 5. For no exception is taken to the particular enunciations of I. 4 or I. 8, although at that stage we are unable to *draw* one triangle with its parts equal to those of the other. J. M. CHILD.

Technical College, Derby.

The Sweet Briar as a Goat Exterminator.

THE introduction of the sweet briar into Australia, in many parts of which it is naturalised, affords a striking illustration of the mode in which the balance of nature may be disturbed in a wholly unforeseen way.

The fruit of the sweetbriar consists of a fleshy receptacle lined with silky hairs which contains the seed-like carpels.

I extract from the *Agricultural Gazette of New South Wales*, vol. xiii., No. 3, March, 1902, p. 313, the following note by Mr. E. A. Weston, a well-known veterinary surgeon of Launceston, Tasmania:—

"With reference to *Rosa rubiginosa*, I thought it might interest you to know that the hairy linings of the fruit caused the death of a number of goats here by forming hairy calculi, which mechanically occluded the lumen of the bowels. These goats were put on the land with the idea that they would eat down the briars and ultimately eradicate them, but the briars came out best and eradicated the goats. The cattle running on the land are also very fond of the briar berries, and from time to time one will die, and on *post-mortem* no pathological changes can be found in any of the organs, nor do the hairy calculi appear in them, although their various stomachs are one mass of the briar seeds."

Kew. W. T. THISELTON-DYER.

Stopping down the Lens of the Human Eye.

IN photography, if the lens is affected with spherical aberration or other defects, or if the aperture is too large for good definition, the operator usually gets over the difficulty by using a smaller aperture or stop. This improves the definition and makes the picture sharp even to the corners of the plate. This process is technically called "stopping down the lens." In amateur landscape work I generally use an aperture or stop with a diameter of one-fiftieth of the focal length of the lens, or $f/50$.

But the human eye has defects, especially as we get old. For instance, the curvature of the crystalline lens becomes too flat, &c., and we have to use spectacles to enable us to read. Reasoning by analogy, diminishing the aperture of the eye by "stopping down the lens" ought to improve defective definition and make the vision sharper, and experiment proves that such is actually the fact. I find that the best effect is obtained by holding a thin metal plate close to the eye, with an aperture in it one-fiftieth of an inch in diameter. This arrangement resembles the old single landscape lens used in photography. The small stop is in front, the lens in the middle and the sensitive plate or retina at the back. I use convex spectacles myself for reading, but with a stop of that size I can easily read small print within 4 inches of the eye (or even less) in a good light without spectacles. I have tried the experiment with several of my elderly friends, and in every case with success. Anyone can try the experiment by means of a pinhole in a card.

I do not know exactly what is the focal length of the lens of the human eye, but supposing it to be half an inch, then with a stop of one-fiftieth of an inch the technical expression for the size of the stop would be $f/25$, or double the diameter of the one I use in landscape photography. I enclose a metal disc with such an aperture. By looking through it I can read the smallest type in NATURE at 4 inches from the eye. WM. ANDREWS.

Steeple Croft, Coventry, April 25.

Prisms and Plates for Showing Dichromatism.

DICHROMATISM, or the change of colour of an absorbing medium with increasing thickness, is usually shown with plates of coloured glass. It is not always easy to obtain the right kind of glass, and only a few of the aniline dyes are suitable for the purpose. The medium should transmit two distinct regions of the spectrum, the absorption coefficient for one being greater than for the other. I have found that it is better to give the medium the form of a prism, for then the transmitted colours are separated, and the more rapid fading of one as the eye is moved from the refracting edge to the base can be followed. A number of years ago I found a small amount of an unlabeled dye which transmitted a red band and a green band, that is, it had a strong absorption band in the yellow and the blue. Thin layers of this dye were bright green, thick layers were blood red. I have never been able to find the dye again, though I have examined a large number of dyes, but I have found that a mixture of commercial "brilliant green" with a little naphthol yellow has

identical optical properties. Brilliant green alone in thin layers is blue rather than green, and though it shows dichromatism, the change from blue to red is not nearly so striking as a change from green to red. The prisms can be made in the following way.

A quantity of Canada balsam is boiled in an evaporating dish until a drop placed on a cold surface becomes quite hard. The dye must not be added until the balsam has cooled almost to the point of becoming thick, otherwise it will be decomposed and a very muddy green result.

Enough brilliant green must be dissolved in the balsam to make it appear deep red in layers 1·5 cm. thick. Thin layers will be found to be blue. The naphthol yellow is now added in quantity sufficient to change the tint of thin layers from blue to green. Possibly some samples of the dye will not require the addition of the yellow, but all which I have tried are improved by the process. A hollow prism is now made by fastening two pieces of thin plate glass between two grooved strips of wood. The base of the prism should be about 2 cm. thick if the strips of glass are 4 cm. long. The plates are warmed with a flame and the coloured balsam poured between them. After the balsam has cooled it is a good plan to run a quantity of melted sealing-wax upon the top of it, which strengthens the prism. An incandescent lamp or gas flame viewed through the prism is seen divided into a green and a red image, the former gradually fading away as the eye is moved towards the base of the prism.

If a larger amount of the colouring matter be added to the balsam and the fluid be pressed out between pieces of plate glass, screens can be made which transmit a very good secondary yellow. Through these screens a sodium flame is absolutely invisible, though a gas flame appears of a colour very closely resembling the soda flame in tint. The colour of the transmitted light depends also on the original composition of the light. By a suitable adjustment of the dyes a screen can be made which appears red by lamplight and green by daylight, illustrating very well the peculiarity of the Alexandrite crystals.

Johns Hopkins University, Baltimore. R. W. WOOD.

Sun-pillar and Parhelion.

As the area over which such effects are visible is of some interest, it may be well to mention that a sun-pillar was visible in Dublin at 7 p.m. on Monday, April 28. It was preceded at 6 p.m. by an unusually fine parhelion display, a portion of which was hidden from my view by houses. Two concentric circles and an inverted arc touching the inner one were visible, with a mock sun at the left hand end of the horizontal diameter of the inner circle, and probably another, hidden from me, on the right. The wind all the previous day had been cold from the north-east, in a fairly clear air, and still blew from about north. The sky was full of streamers and wisps of cirrus cloud. Doubtless a far more complete account can be given by other observers. GRENVILLE A. J. COLE.

Royal College of Science, Dublin, April 30.

A Rare Wild Sheep.

SPORTSMEN and naturalists will be interested to learn that Mr. Talbot Clifton, who has recently been travelling in northern Siberia, has brought home from the valley of the Lena the skin and skull of a wild sheep of which no complete examples have hitherto been known in England. This sheep is the *Ovis borealis* of Severtzoff, a near ally of the bighorns of Kamchatka and Alaska. As it has no English name, it may well be known as Clifton's bighorn. The skin is being mounted by Rowland Ward, Ltd., and will before long be exhibited to the Zoological Society. R. LYDEKKER.

Beechen Hedges on Elevated Ground.

IN your issue of April 10, Mr. Wm. Gee, of Buxton, expresses his surprise that some beechen hedges and smaller trees in his neighbourhood have maintained their foliage through this winter, "contrary to the habit of deciduous trees."

I beg to state that in Denmark, where beeches abound, these trees always behave in the same manner as those in Buxton did this year. An underwood of young beeches, densely covered with dry, brown, rattling foliage, is quite a characteristic feature of Danish woodland scenery.

It would be most interesting to learn whether the beeches in England really used to throw off their leaves in autumn, and to ascertain the causes of such a different behaviour of the same species of tree in two countries of approximately the same climate. How this holding of the leaves could be a protective device to the individual young beech I cannot imagine; but to the whole underwood, or wood, this phenomenon might be protective, keeping out the cold winds of winter.

18 V. Boulevard, Copenhagen. JUL. WULFF.

IN reply to the interesting communication from Copenhagen anent the Buxton beeches, I would remind your correspondent that, as stated, the matured trees in the plantations hereabouts drop their leaves in the autumn as usual, the retention of them being observable only upon small young trees, and in the beechen hedges, and that this effect is not noticed, in this neighbourhood, for the first time.

It may give colour to the suggestion that this holding of the past season's leaves is an extra device under pressing circumstances to remember that the tissue of such accessory organs as scales, bracts and stipules is of feebly conducting material, and that these dry beech leaves, acting as such, would also enclose a film of air which would tend to give fuller protection from the frosts which this winter have been uncommonly severe, the local observatory (in connection with Westminster) registering down to 3° Fahr.

We have the highest authority for considering the beech as an unusually resourceful tree, as shown in its vernation, the growth of its bark and the care of its seeds; and it would not be surprising to hear of its making a special defence against a special attack, and being successful as a "survival of the fittest."

Barlbro' Cottage, Buxton, April 28. WM. GEE.

CHEMICAL INSTRUCTION AND CHEMICAL INDUSTRIES IN GERMANY.

NO more striking illustration of the position which Germany has won for herself in chemical technology, and of the industrial preeminence which she has thereby secured in one of the most highly developed branches of the chemical arts, could have been given than that afforded by Prof. Witt in the lecture theatre of the Royal Institution on Friday evening, March 21; and to the observant eye no object-lesson could be more significant or more forcible than that presented by the remarkable series of chemical products, the outcome of the work of German manufacturers, which Prof. Witt had gathered together to point the moral of his discourse.

In a few years we shall behold the extinction of one more agricultural industry, and the indigo plantations of India will have gone the way of the madder fields of Avignon. The death-knell of natural indigo has been sounded; the planter may struggle on for a while in a futile effort to withstand the inevitable; prejudice and trade customs may delay the fall of the fateful sword; but the machinations of the German chemist, backed by the German capitalist, have slowly but surely compassed his ruin, and it is but a question of time when it will be accomplished.

The conditions which have conduced to this result have been indicated, time and again, in these columns. But no more eloquent commentary on these causes could be adduced than is afforded by the report on chemical instruction and chemical industries in Germany recently made to the Foreign Office by Dr. Frederick Rose, His Majesty's Consul at Stuttgart, and which has recently been published.[1]

This report deals with the facilities, and expenditure, for chemical instruction at the two Prussian Technical High Schools at Berlin and Hanover, and at the University of Berlin, and is supplementary to a report on chemical instruction and chemical industries in Germany already made public by the Foreign Office.

The following brief analysis of this report will serve to show by what methods the State has deliberately

[1] Diplomatic and Consular Reports, No. 573, Miscellaneous Series.

paved the way for the result foreshadowed in at least one branch of chemistry in Prof. Witt's discourse.

Let us take the Berlin Technical High School first. In this school there are six fully qualified professors for the following branches of chemistry:—(1) Organic chemistry; (2) inorganic chemistry; (3) chemical technology; (4) metallurgy; (5) electrochemistry; (6) photochemistry.

In addition there are six lecturers for the following branches:—(1) Chemistry of foods, including analytical and bacteriological methods; (2) agricultural-chemical technology (sugar, beer, spirits, &c.); (3) vegetable and animal fats, oils, &c., investigation of mineral oils and naphtha products; (4) designing of chemical works and plant; (5) architectural chemical technology; (6) physical chemistry, thermochemistry, &c.

Finally, twelve *privat docenten*, or private lecturers, for the following branches:—(1) Electrolytic metallurgy; (2) chemistry of foods; (3) ceramics; (4) chemistry of the growth of plants; (5) investigation of oils, fats and naphtha; (6) technology of proteids and albuminoids; (7) repetition of organic chemistry; (8) chemistry of cements, mortar, plaster, &c.; (9) qualitative and quantitative analysis; (10) coal tar dyes; (11) terpenes and camphors; (12) modern synthetic drugs.

The following table gives the number of professors and students for a series of years from 1885–99:—

	1885.	1890.	1895.	1899.
Professors ...	4	5	5	6
Lecturers ...	3	2	6	8
Private lecturers	5	3	11	12
Assistants	7	13	13	15
Students ...	89	172	171	278

It will be seen that in 1899 there were no fewer than 41 professors, lecturers, private lecturers and assistants to 278 students, or about one instructor to seven instructed.

The laboratories for organic chemistry, photochemistry, metallurgy and chemical technology are contained in a building erected in 1884. The increase in the number of students has now rendered the erection of new buildings necessary; these will be begun this year, and will probably cost 27,500*l.* exclusive of the site, which is valued at 10,000*l.* For the same reason, a new building will shortly be erected for the electrochemical laboratory, which is at present located in the palatial building of the Technical High School.

The department for instruction in chemistry at the Hanover Technical High School differs from that of the Berlin Technical High School, inasmuch as the chemical-technical and electro-technical branches are combined in one department.

The principal chairs of chemistry are four in number:—(1) Inorganic chemistry; (2) organic chemistry; (3) chemical technology; (4) electrochemistry.

The following table gives the total number of professors, &c., and assistants and students for a series of years:—

	1885.	1890.	1895.	1899.
Professors ...	4	5	5	6
Lecturers ...	2	1	1	2
Private lecturers	—	1	4	4
Assistants ...	4	5	9	11
Students ...	64	81	192	285

In 1899 the proportion of instructors to instructed was 23 to 285, or about 1 to 12.

The department of chemistry at the Berlin University forms one of the subdivisions of the faculty of philosophy, and the professors of chemistry are members of the philosophical faculty.

The professorial staff includes:—(1) One professor of organic chemistry; (2) one professor of inorganic chemistry; (3) one professor of pharmaceutical chemistry; (4) one extraordinary professor of chemical technology; (5) one extraordinary professor from the Berlin Technical High School; (6) one extraordinary professor from the Veterinary High School; (7) one extraordinary professor from the Imperial Patent Office; (8) one extraordinary professor from the Royal Department for Testing Explosives; (9) three extraordinary professors who also form the managing board of the two principal chemical institutes (see under); (10) twelve private lecturers; (11) twenty assistants in the different laboratories for inorganic, organic, pharmaceutical and technological chemistry.

The chemical department of the Berlin University possesses the following subdivisions for chemical instruction:—(1) The First Institute of Chemistry, conducted by the professor with a managing board of two extraordinary professors and eleven assistants; (2) The Second Institute of Chemistry, with one managing extraordinary professor and three assistants; (3) The Chemical-Technological Institute, with one extraordinary professor and two assistants; (4) The Chemical-Pharmaceutical Institute, with one extraordinary professor and four assistants.

The report does not give the number of students of chemistry who have studied at Berlin during the past, as they are not inscribed specially as students of chemistry, but are entered as belonging to a subdivision of the philosophical faculty. It is not possible, therefore, to determine exactly what proportion of the total natural science students were actually students of chemistry, although there is reason to assume that the proportion is large:—

	Students in the Philosophical Faculty.	Students in the subdivision of natural science.
1885	1955	813
1890	1761	515
1895	1551	512
1899	2162	784

It is stated that the decrease in the number of students for the years 1890 and 1895 was partially caused by the lack of sufficient and suitable accommodation in the chemical laboratories and lecture-rooms, a defect now remedied by the erection of the splendidly equipped building in the Sophien-Strasse.

The following table gives the annual expenditure for new apparatus, instruments, chemicals, repairs, &c., of the above-mentioned four chemical institutes at the Berlin University. The sums given do not include the salaries of teachers, assistants, or laboratory servants:—

	First Chemical Institute.	Second Chemical Institute.	Technological Institute.	Pharmaceutical Institute.	Total.
	£	£	£	£	£
1885 ...	645	724	476	275	2120
1890 ...	719	564	398	275	1956
1895 ...	794	564	398	275	2031
1899 ...	1052	614	398	275	2339
1901 ...	2792	614	398	275	4079

From the above table it is seen that the annual expenditure for the First Chemical Institute for instruments, apparatus, chemicals, &c., alone, *i.e.* apart from the salaries of the professors, lecturers, &c., has increased more than fourfold since 1885.

The First Chemical Institute was erected between 1860 and 1870 at the following cost:—

Building site	£13,500
„ expenses	27,505
Internal equipment	3,985
	44,990

During the last fifteen years, however, the great increase in the number of students of organic chemistry drawn to Berlin by the fame of Hofmann and Emil Fischer has rendered necessary the erection of a new building for the First Chemical Institute. This was built between 1897 and 1901 at a total expenditure of 70,000*l.*,

to which 7500*l.* was added for the purchase of instruments, apparatus, &c. The value of the building site was probably 30,000*l.* to 40,000*l.*

The Second Chemical Institute and the Technological Institute were both built after 1870, and have repeatedly received large sums for apparatus and instruments.

A new building is at present in course of erection for the Institute of Pharmaceutical Chemistry, estimated to cost 26,250*l.* without the value of the site, which may amount to 10,000*l.* The annual vote for instruments, &c., is to be raised from 225*l.* to 750*l.*

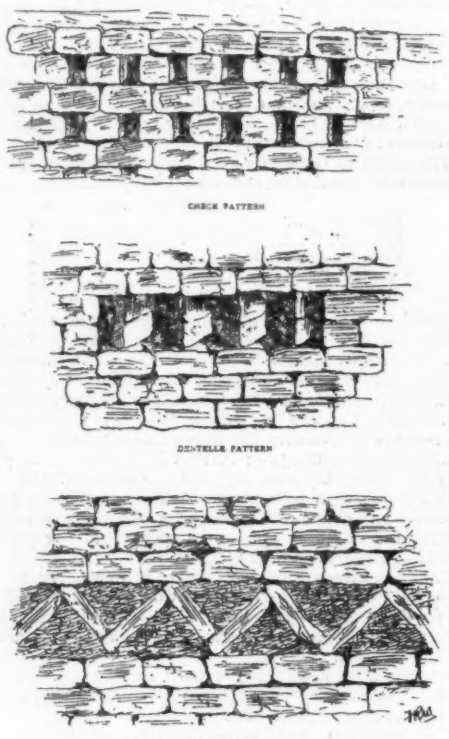
These figures, as Consul Rose states, are eloquent enough, and show clearly what facilities are provided in these great institutions for tuition in all branches of chemistry. "Finally they show—and this is, perhaps, the most significant indication of all—that the Prussian State, in spite of the expenditure already incurred, and the leading position attained by the chemical industries, is far from regarding the present admirable means of chemical instruction as adequate for future contingencies, but is at all times, after representations from the requisite industrial and educational quarters, prepared for further lavish outlay should future developments reveal this necessity." T. E. THORPE.

RHODESIA AND OPHIR.[1]

IN this handsome and copiously illustrated volume are embodied the results of six years' (1895–1900) systematic exploration amongst the numerous prehistoric remains of all kinds which are widely scattered over the whole region between the Zambesi and the Limpopo, and even range at some points into the conterminous districts of North Transvaal and Bechuanaland. During the operations, which were conducted under grants from the Chartered Company licensing these researches, the authors, with their indefatigable colleague, Mr. George Johnson, personally inspected nearly two hundred ruins, a list of which is here given and a great many of which are described in more or less detail. They further tell us that, so far from being completed, the work of exploration has scarcely been more than well begun, that their precursors and contemporaries—Bent, Mauch, Baines, Maund, Willoughby, Swan, Schlichter, White—have merely scratched the surface, and that of more than five hundred temples, citadels, enclosures, chains of forts, gold workings and terraced slopes reported from various districts and covering a total area of at least 115,000 square miles, not a tenth part has yet been thoroughly examined. This will be read with surprise by those archæologists who supposed that after Bent and Swan's classical descriptions of the "Great Zimbabwe" and a few neighbouring monuments, little more remained to be discovered. But the statement is supported by abundant first-hand evidence, and it is shown that Zimbabwe itself "is still practically unexplored," while elsewhere the original floors of the *earlier* structures still rest for the most part buried under ten or even fifteen feet of the accumulated débris of ages.

That there are earlier and later structures, bespeaking either a long continuous or an intermittent occupation of the land by foreign intruders, is placed beyond all doubt, and a comparative study of the various groups so far explored has enabled the authors tentatively to classify them in four categories, clearly indicating time sequences ranging from at least 1000 B.C., possibly even 2000 B.C., down to the advent of the Mohammedan Arabs and Portuguese. The buildings of the first period, of which the Great Zimbabwe is typical, are marked by great solidity and superior workmanship, with massive walls of dry masonry resting on the bed-rock, often 15 to 17 feet thick at base, batter-backed both inside and outside, with no false courses, but bonded throughout their entire width and diversely ornamented with dentelle, check, chevron and especially herring-bone patterns (Fig. 1). These are assigned with Bent, Schlichter and myself to the South Arabian Himyarites, and are compared—in their characteristic elliptical curves, the absence of mortar and other details—with the ruined temples and palaces of Marib (Maraiaba Bahramalakum), capital of the ancient Sabæan empire.

To the Phœnician successors of the Sabæans are assigned the less substantial and otherwise somewhat inferior structures of the second period, which are either superimposed upon, or else form extensions of, the earlier monuments, and also occur by themselves generally in districts farther removed from the east coast. This is, of course, what we should expect to find on the assumption that the Himyarites were the first arrivals, and settled in the rich auriferous tracts (Manica, Sabi basin, Mashonaland) lying nearest to the seaboard. Yet remains of the first period are also met sporadically farther west in various parts of Matabililand, which may be explained either by assuming a very long pre-Phœnician Sabæan occupation or a joint Sabæo-Phœnician occupation probably in Solomonic times, when we know that peaceful relations prevailed between the Israelites, Hiram, King of Tyre, and Balkis, Queen of Sheba. It was then that the auriferous stream, which had already reached Palestine during the reign of David, rose to high-water level, and it is here suggested that



DECORATIVE PATTERNS

FIG. 1.

[1] "The Ancient Ruins of Rhodesia." By R. N. Hall and W. G. Neal with above seventy illustrations, maps and plans. Pp. xxvii + 396. (London: Methuen and Co., 1902.) Price 21*s.* net.

the sources of that stream are to be sought in Rhodesia, where the ancient gold-workings are stated to have yielded a total output of at least 75,000,000*l*. Then it is asked, "Where else but Rhodesia did the ancient Sabæans obtain the vast supply of gold which they purveyed to Phœnicia, Egypt and the rest of the then known world? The only answer possible at present is: Rhodesia; and the later discoveries in Rhodesia only serve to strengthen and emphasise this answer." Hence the inference that Rhodesia was the Biblical Ophir, though the point is not regarded as settled. Indeed, in their preface, written after the appearance of my "Gold of Ophir," the authors seem inclined to adopt the modified view that Rhodesia was the source, and Ophir n South Arabia the importer and distributor, of these reasures throughout the ancient world. My conclusions bearing on this solution of the question are given in full, and seem to be tacitly accepted.

But the authors remind us more than once that their object has not been to advocate any particular theory, but "to allow facts to speak for themselves." Judged from this standpoint, the work must be pronounced an unqualified success. It would be impossible to improve upon the general plan, by which law and order is introduced into a chaos of small but indispensable details, brought together during six years of continuous exploration amid the ancient ruins south of the Zambesi. Students of Rhodesian antiquities will also feel grateful for the aid afforded by the accompanying large-scale map, which covers the whole ground and shows in red lettering the exact position of the five hundred ruined sites which have so far been either described or reported in every part of Rhodesia.

Limitation of space prevents more than the merest reference to many incidental matters, such as the structures now recognised as slave-pits, the extensive terraced slopes of the Inyanga and Mount Fura districts exactly resembling those of the Yemen uplands, the quartz crushers, the gold-smelting works, the numerous gold crucibles showing gold in the flux, and especially the massive gold objects—beads, bangles, plates, wire, pegs, nails, ferrules—which were so characteristic of the monuments of the first period, and of which more than 2000 ozs. have already been collected (Fig. 2). Some of the ornaments, obviously manufactured on the spot and displaying considerable artistic taste and technical skill, were found on the original cemented floors, while others were taken from the skeletons of men, women and children buried under the floors. "All the branches of the goldsmiths' art were practised by them, including gold wire drawing, beating gold into thin sheets, plating iron and bronze with gold, and burnishing" (p. 93). It is evident from such details as these, as well as from the slave-pits, the chains of forts stretching along the old highways seawards, and the terraced slopes erected with prodigious labour for agricultural purposes, that the country was not merely conquered, but settled, that it was a true colony in the modern sense of the term, and was held as such by the South Arabian Himyarites for many generations. But enough has perhaps been said to show the great value of a work which places the Ophir question on a new footing and sets history back some two millenniums in the austral world.

A. H. KEANE.

FIG. 2.—Gold ornaments and pottery discovered at Dhlo-Dhlo and M'telegwa Ruins.

THE INSTITUTION OF ELECTRICAL ENGINEERS AND ELECTRICAL LEGISLATION.

REFERENCE is made in our notes columns to the ceremony performed by Sir Frederick Bramwell in connection with the South Wales electrical power distribution scheme. The Bill for the promotion of this scheme was, it will be remembered, one of six before a Select Committee of Parliament presided over by Sir J. Kitson last year. These Bills gave rise to a paper read by Mr. W. L. Madgen before the Institution of Electrical Engineers on "The Electrical Power Bills of 1900: Before and After" (*Journal Inst. Elec. Engin.* vol. xxx. p. 475), in which the author dealt with the question of England's backwardness in the development of electrical engineering. The paper may be considered in some respects one of the most important communicated to the Institution of late years. It led to a prolonged discussion—the report of the proceedings occupies more than sixty pages of the Institution's *Journal*—in which, though various opinions were expressed as to the cause of our deficiency, the general conclusion seemed to be reached that the backwardness was due largely to the out-of-date and grandmotherly legislation which governed electrical undertakings. As a result, a powerful committee was appointed by the council of the Institution to report on the subject and advise the council whether they should take any action, and if so what action, to improve the position. The members of the committee were the following:—Profs. W. E. Ayrton, J. Perry and S. P. Thompson, Major P. Cardew, Lieut.-Colonel R. E.

Crompton, and Messrs. S. Z. de Ferranti, R. Hammond, H. Hirst, J. E. Kingsbury, W. L. Madgen, W. M. Mordey, R. P. Sellon, A. Siemens, C. P. Sparks, J. Swinburne and A. A. Campbell Swinton. This committee, after holding eleven meetings and collecting a quantity of evidence, has just published its report, which has been adopted by the council of the Institution. As the subject is one of vital importance, not only to the electrical profession, but to the whole nation, it will be of interest to consider this report in some detail.

By their first resolution the committee state that "the development of electrical science in the United Kingdom is in a backward condition as compared with other countries, in respect of practical application to the industrial and social requirements of the nation." As a case illustrating this contention, the American equipment of the Central London Railway will occur to everyone; the undisputed competition between Messrs. Ganz and Co. and the Westinghouse Company, two foreign firms, for the electrical equipment of the Metropolitan and District Railways affords a second illustration. The South Wales distribution scheme is a third case in point, for it will be seen from the note to which we have referred already that though the engines are to be of English make, the electrical generators are to be supplied from abroad.

The resolutions which follow attribute the backwardness largely to "the restrictive character of the legislation governing the initiation and development of electric power and traction undertakings, and the powers of obstruction granted to local authorities," and point out that "local boundaries have usually no reference whatever to the needs of the community in regard to electric supply and traction," and that the development of these undertakings offers the most favourable means of relieving congested centres. The economic importance of the question is thus clearly insisted upon by the committee. As regards the power of local authorities, it is recommended that the Electric Lighting Acts 1882-8 and the Tramways Act 1870 should be amended in so far as they enable local authorities to veto or delay electrical undertakings of proved public utility. A similar recommendation was made by a joint committee of the two Houses of Parliament in 1898, but nothing has been done so far to give effect thereto.

In addition, it is pointed out that the technical staffs of the Government departments are inadequate for present needs, and finally the committee recommends that a deputation from the Institution of Electrical Engineers should wait on the Prime Minister to urge the removal of the present disabilities and restrictions. It is to be hoped that this final resolution will take effect and will produce the desired result. It is not to be supposed that the legislative difficulty is the only one which has hampered electrical development in England, but it is unquestionably one of the greatest. As more than one speaker pointed out in the discussion on Mr. Madgen's paper, we have to cope with the superior organisation of foreign manufactories, due to the recognition of the high value of scientific training and the closer assimilation of theory and practice. In the industrial war which we have to carry on it is, as Prof. S. P. Thompson said, "brains really against which we have to fight." And we have to meet something more than this, namely, the experience which foreign manufacturers have gained in constructing electrical machinery, not for their own requirements merely, but for ours also. If we are to make up our leeway and be successful in this struggle, it is essential that we should not be hampered by out-of-date legislation. Reform may be necessary in other directions as well, but that does not lessen the need for reform in this direction. Anything that can be done to make our path more easy should be done without delay, lest we find, when it is accomplished, that we are too late. To do what is in their power for the furtherance of this object is the interest, not only of electrical engineers, but of all who do not desire to see our commercial supremacy pass to other countries.

DECORATIVE PLANTS FOR GARDENS.[1]

IN the second volume of the fifth series of the *Atti del Reale Istituto d'incoraggiamento di Napoli* (1901), Dr. Nicola Terraciano has an elaborate paper on the wild plants of Italy that are most suitable for decorative purposes in gardens. Such indications are greatly needed in many countries besides Italy. At this season of the year, if the botanist or the flower-lover pays a visit to a garden, or particularly to a flower-show, he will see hundreds of daffodils, for instance. If by chance he visits another locality he will still see hundreds of daffodils of the same kind. They are very beautiful, and to the student of evolution most interesting and most worthy of study. But after a time they get somewhat monotonous, and the visitor begins to long for a change. These daffodils of which we have been speaking may be referred to some two or three, or at most half a dozen, species only, but if we turn to the memoir before us we find some twenty species enumerated, and we wonder why more of them are not pressed into the service. Again, if we look to the "schedules" of the flower-shows at the Cape of Good Hope; or of any of our Australian colonies, we find slavish imitations of European procedures—chrysanthemums galore in their season, daffodils, roses and the like, just as in an English exhibition—but the representatives of the local floras are not represented. And yet the Cape flora and the West Australian flora are probably much richer in plants suitable for cultivation than those of any similar areas in the world. What a disappointment to the botanist to visit a flower-show in South Africa or Australia and find little or nothing but chrysanthemums when he is eager to see the beauties of the Cape Peninsula and of the Swan River.

Dr. Terraciano evidently holds the same views, for he puts before us a long list of the plants of Italy more or less suitable for garden decoration. He points out how great are the resources of the Italian peninsula, stretching as it does from Alpine almost to sub-tropical regions, with a long coast-line, with marshes, heaths, forests and endless diversity of soil, and situation clothed with a corresponding diversity of vegetation.

It is no wonder, then, that his list is a long one. There are fourteen species of tulips, for instance. Some of the plants might perhaps have been omitted, such as some of the eight species of Juncus. To the botanist pure and simple mere beauty is, of course, subordinated to other considerations. We remember a botanist's garden at Reigate many years since which was full of interesting things, but when the garden changed hands, the new proprietor is recorded to have said, when giving orders for their destruction, that he "must draw the line at docks"!

Dr. Terraciano indicates the soils most suitable for the cultivation of particular plants, and recommends for many of them a compost of peat, fragments of chestnut wood and leaf-mould.

Considering what a favourable nidus this would in our damp climate form for fungus spawn, we should hesitate to employ it on a large scale. Cultivation in sphagnum moss we first saw in Italy many years ago, and succeeded in growing sarracenias in it in a London suburb for a time.

[1] "Le piante della flora italiana più acconce all ornamento dei giardini."

NOTES.

THE following fifteen candidates have been selected by the council of the Royal Society to be recommended for election into the Society:—Mr. H. Brereton Baker, Prof. Henry T. Bovey, Prof. Rubert Boyce, Mr. John Brown, Mr. William Bate Hardy, Mr. Alfred Harker, Mr. Sidney S. Hough, Mr. Robert Kidston, Mr. Thomas Mather. Mr. John Henry Michell, Mr. Hugh Frank Newall, Prof. William M. Flinders Petrie, Mr. William Jackson Pope, Mr. Edward Saunders and Dr. Arthur Willey.

THE gold medal of the Linnean Society of London has this year been awarded to Prof. Rudolf Albert von Kölliker, of Würzburg, in recognition of his distinguished contributions to zoological science. The medal will be presented at the forthcoming anniversary meeting, which will be held at Burlington House on May 24.

WE are glad to learn that Prof. Rudolph Virchow has now recovered in what may be termed a highly satisfactory manner from the serious accident with which he met a few months ago. A few days ago he was able to leave Berlin for the country, where he will reside for some months to come, leave of absence having been granted him for the whole summer term. In the meantime, his duties of lecturing and examining will be undertaken by his three principal assistants.

AT the annual meeting of the Institution of Civil Engineers, held on April 29, Mr. J. C. Hawkshaw was elected president and Sir William White, K.C.B., Mr. F. W. Webb, Sir Guilford Molesworth, K.C.I.E., and Sir Alexander Binnie were elected vice-presidents of the Institution.

NEWS from the Swedish Antarctic expedition under Dr. Otto Nordenskjöld has been received by the *New York Herald*. The expedition has disembarked at Snow Hill, Louis Philippe Land, accompanied by the surgeon, Dr. Eklof, Lieutenant Sobral and two sailors. From Cape Horn Dr. Nordenskjöld tried to sail the *Antarctic* directly south, but too many icebergs were encountered and there was danger of the ship being imprisoned in the ice for a long time, so he decided to change his course. The expedition will remain at Snow Hill until next summer.

THE conversazione of the Institution of Electrical Engineers will be held in the Natural History Museum, South Kensington, on Tuesday, July 1. In view of the fact that the Tramways and Light Railways Congress will then be sitting, and many of the foreign delegates to the Congress are likely to attend the conversazione, and that the Incorporated Municipal Electrical Association will also open its convention in London on the following day, one of the large side galleries will be opened for the conversazione in addition to the central hall of the Museum.

THE seventh annual congress of the South-Eastern Union of Scientific Societies will be held at Canterbury on June 5–7. On Thursday, June 5, the president-elect, Dr. Jonathan Hutchinson, F.R.S., will deliver the annual address. The following papers will be read during the meeting:—"The Marine Aquarium, without Circulation or Change of Water," by Mr. Sibert Saunders; "Recent Researches on Mimicry in Insects," by Prof. E. B. Poulton, F.R.S.; "The Preservation of our Indigenous Flora, its Necessity, and the Means of Accomplishing it," by Prof. G. S. Boulger and Mr. E. A. Martin; "Borings in the Neighbourhood of Canterbury," by Mr. W. Whitaker, F.R.S.; "Mycorhiza, the Root Fungus," by Miss Annie Lorrain Smith. There will be an excursion to the South-Eastern Agricultural College, Wye, by the kind invitation of the principal, Prof. A. D. Hall, who will explain the valuable experimental work now being carried on in connection with the college.

THE Lawes Agricultural Trust Committee has appointed Mr. A. D. Hall, principal of the Agricultural College, Wye, to succeed the late Sir Henry Gilbert, F.R.S., as director of the Rothamsted Experimental Station. Principal Hall, who graduated at Oxford, and has since distinguished himself by his successful development of Wye College as a centre of agricultural education, will thus carry on the experiments which were jointly conducted by Sir John Bennet Lawes and Sir Henry Gilbert for nearly sixty years, and are now of world-wide fame. It is confidently expected that not only will the continuity of past work be maintained, but that agricultural science will be advanced in many new directions at this well-known centre of research.

THE *Times* announces the death, at Newcastle-on-Tyne, of Mr. John Glover, the inventor of the "Glover Tower," the introduction of which represented a great advance in the manufacture of sulphuric acid. Mr. Glover did not patent his invention, and never derived much pecuniary profit from it, but chemical manufacturers know the value of the boon he conferred on them, and the Society of Chemical Industry testified to the importance of his work by awarding him in 1896 its gold medal for conspicuous service to applied chemistry.

THE death of Prof. H. von Pechmann, in sad circumstances, on April 24, is a great loss to the science of chemistry in Germany. He had been ill for a long time past, suffering, it would appear, from an incurable nervous trouble and frequent attacks of mental depression. That he might be restored to health he was granted a long leave of absence, and on resuming his duties was seemingly better than he had been for some time. But soon after his return he again become depressed and, while in that state, put an end to his life by taking strong sulphuric acid in his laboratory. Prof. von Pechmann was only fifty-two years of age, having been born in 1850, and the University of Tübingen will feel his loss very keenly. Appointed to the chair of chemistry at the last-mentioned University in 1895 in succession to Prof. Lothar Meyer, his skill in teaching and his personal charm were such that the number of students under him increased very considerably and, as a consequence, the enlargement of his laboratory and lecture-theatre was regarded as necessary. The late professor was a native of Nüremberg, and descended from an old Bavarian family of great social influence.

THE council of the Institution of Civil Engineers has made the following awards for papers read and discussed before the Institution during the past session:—a Telford medal (in standard gold) to Mr. W. M. Mordey, and a George Stevenson medal (in standard gold) to Mr. B. M. Jenkin; a Watt medal (in standard gold) to Mr. J. A. F. Aspinall; and Telford premiums to Messrs. W. C. Copperthwaite, A. H. Haigh and J. Davis. The council has also awarded the Howard quinquennial prize of the Institution to Mr. R. A. Hadfield (of Sheffield) for his scientific work in investigating methods of treatment and new alloys of steel, and on account of the importance, in industry, of some of the new products introduced by him. The presentation of these awards, together with those for papers which have not been subject to discussion and will be announced later, will take place at the inaugural meeting of next session.

THE seventy-third anniversary meeting of the Zoological Society of London was held on April 29, the chair being taken by the Duke of Bedford, K.G., president of the Society. The report of the council announced that the Prince of Wales had become a vice-patron of the Society. In February last the council awarded the gold medal of the Society to Sir Harry H. Johnston, G.C.M.G., K.C.B. Sir Harry Johnston received the silver medal of the Society in 1894 in acknowledgment of his zoological investigations in

British Central Africa. Since that date he has not ceased his endeavours to promote the advance of zoological discovery in the several posts that he has occupied in various parts of Africa, and has especially distinguished himself by the discovery, on the confines of Uganda, of the wonderful new African animal the okapi. The silver medal of the Society was awarded to Mr. E. W. Harper, of Calcutta, who during the past two years has presented to the Society a large number of living Indian birds new to the collection. These medals will be delivered personally to the recipients at the general meeting on June 19. The total income of the Society during the past year was 29,350*l.*, and the ordinary expenditure amounted to 27,526*l.* The extraordinary expenditure paid in 1901, amounting to 4530*l.*, was devoted entirely to new buildings and works in the Gardens. The most important works carried on at the Gardens during the past year were the rebuilding of a portion of the green-houses and the new drains to the hippopotamus-house. Besides these works, a new ape-house for the better accommodation of the anthropoid apes was commenced last autumn, and a sum of 4000*l.* has already been expended upon it. The main feature of the new building is the entire separation of the part appropriated to the spectators from that in which the animals are lodged by a glass screen, so that the animals may be kept at a nearly uniform temperature. The number of visitors to the Society's Gardens in 1901 was 725,685, showing an increase of 28,507 as compared with the previous year and an increase of 61,130 above the average of the previous ten years. The number of animals living in the Gardens on December 31 last was 2922, of which 789 were mammals, 1575 birds and 558 reptiles and batrachians. Amongst the additions made during the past year, 10 mammals, 58 birds, 21 reptiles, 3 batrachians and 2 fishes were registered as new to the collection.

THE Electrochemical Society, which has just been founded in America, held its inaugural meeting at Philadelphia on April 3–5. The president is Prof. J. W. Richards, of Bethlehem, and the list of officers contains the names of most of the best-known American electrochemists. During the three days' session, twenty papers were read and discussed, and arrangements are being made, we understand, for the publication of the proceedings. The formation of this society is a sign of the importance which electrochemistry has attained in the United States. Tentative proposals have been made at various times for the formation of a similar society in this country, but it is doubtful whether there are a sufficient number of workers in this field to ensure its success. Perhaps the founding of the American society may stimulate English electrochemists to further effort in this direction. Some such organisation, in conjunction with the already existent electrochemical journal, might have the effect of bringing this country into line with Germany and America in this branch of electrical science.

WE noticed in these columns last year the starting of the first large power distribution scheme in England at Newcastle-on-Tyne. Last week, on April 29, Sir Frederick Bramwell laid the foundation-stone of the first generating station of the South Wales Electrical Power Distribution Company, thus inaugurating the second scheme in this country for the supply of electricity in bulk. The area that this company proposes to supply covers Glamorgan and a part of Monmouth, a total area of slightly more than 1000 square miles. The district is one eminently suited to the electrical distribution of power, as it includes collieries, steel-works, tin-plate and copper works and numerous other factories of different kinds. The generating station now being constructed is on the banks of the Taff, near Pontypridd, and it is expected that it will be completed in about eighteen months. The plant is to consist of five sets each having a capacity of 2250 kilowatts, making a total capacity of about 15,000 horse-power. Willans engines are to be used, driving three-phase alternators by Messrs. Ganz and Co., of Budapesth. These will generate current at 12,000 volts, which will be converted to low-tension continuous current to be supplied to consumers. The steam generating plant is to consist of twenty-four water-tube Niclausse boilers, which are being built by Messrs. Willans and Robinson at Chester. Three other generating stations will be erected later. It is estimated that the cost of generating power will be slightly over three farthings a unit, which will enable it to be sold cheaply whilst allowing a considerable margin for profit.

THE *Journal of Physical Chemistry* for January contains a paper by Prof. Kahlenberg on instantaneous chemical reactions and the electrolytic dissociation theory. A previous paper by the same author, in which he discussed the validity of the ionic theory of electrolysis, has been abstracted at considerable length in NATURE (vol. lxv. p. 305). In this second communication Prof. Kahlenberg attacks the theory that instantaneous chemical reactions are dependent upon ions; the question that the author sought to answer was whether these reactions, causing precipitation by double decomposition, can take place in non-conducting solutions. He finds that benzene solutions of chlorides, such as HCl, $SnCl_4$, PCl_3, $AsCl_3$ and $SiCl_3$, precipitate cupric chloride from a benzene solution of copper oleate. There is thus a reaction precisely analogous to the precipitation of silver chloride from silver nitrate solutions by means of a soluble chloride, although in this case both the reacting solutions are excellent insulators. The benzene copper and the benzene chloride solutions are no better conductors than benzene itself, nor is there any increase of conductivity at the moment of precipitation. Elaborate precautions were taken in all the experiments to exclude any trace of moisture. In addition, freezing- and boiling-point measurements were made on the copper oleate solution, as well as the conductivity tests, which showed that there was no electrolytic dissociation. The author concludes that, instantaneous reaction in insulating solutions having been thus demonstrated, similar reactions in aqueous solutions cannot be explained on the ionic hypothesis without further proof.

A COPY of the results of meteorological and magnetical observations at Stonyhurst College Observatory for 1901 has been received. The observations are very complete and are especially valuable from the fact that the means can be compared with those for the last fifty-four years. The total fall of rain in the year was close upon 39 inches, being 8 inches below the average. The shade temperature reached 89° on July 20, which is the highest recorded at Stonyhurst. The lowest shade temperature registered during this long series was 4°·6, on January 15, 1881. Drawings of the solar surface were made on 235 days. An appendix contains the results of meteorological observations taken at Malta, with means for the last eighteen years.

IN *Symons's Meteorological Magazine* for March, there are several communications from correspondents referring to the sun-pillar of March 6. It appeared to have been most strikingly visible in the south and south-west of England, and was also observed at some inland stations. An observer at Bridport states that at 6h. 10m. p.m. it shot upwards 10° perpendicularly above the horizon, and that its colour was yellow, tinted with orange. At 6h. 25m., when its altitude had lessened to 5°, it showed a remarkably intense rosy tint, and at 6h. 40m. scarcely a trace was left. The theory of the formation of the phenomenon is that the effect of a luminous shaft is given by reflection from the under surfaces of minute crystals of ice floating horizontally. The Rev. S. Barber points out that the result is precisely similar to the formation of a long shaft of light by the reflection of the moon on the rippled surface of the sea.

A HISTORICAL account of the discovery of voltaic electricity is contributed to Nos. 642 and 643 of *Prometheus* by Dr. F. Dannemann. It deals chiefly with the discoveries of Volta, Galvani, Oersted and Ampère, and the author considers that at the beginning of the twentieth year of the nineteenth century the chief fundamental facts concerning electricity had been made known with the exception of induction, which was left for the genius of Faraday to discover.

THE tendency of streams to diverge from a straight path and to assume a zigzag course forms the keynote to a paper by Mr. Lewis B. Haupt, on single curved *versus* double straight jetties, in the *Journal* of the Franklin Institute for April. Where a river assumes a sinusoidal form there is a constant tendency of the current to eat away the concave banks and to deposit silt on the convex ones, and the author considers that if this natural tendency is counteracted by confining the stream between two parallel straight jetties, much expense in dredging out the river bed will be incurred, whereas the construction of a single wall at the concave side of bends will enable Nature to do her own work by keeping the channel scoured at the side of the wall and forming a convex training bank at the other side. This method has been tried with success at Aransas Pass in Texas, and the author is of opinion that single concave reaction-jetties may economically be adapted to the opening of the delta mouths of silt-bearing streams.

A SHORT note in the *Journal* of the Royal Microscopical Society, on a paper by Mr. G. Marpmann on distinguishing between *Pleurosigma angulatum* and *P. balticum* under low powers, may well suggest an interesting field of observation in the diffraction colours of some of the more regularly marked diatoms, and the possibility of measuring the striations of the valves even by naked eye observations. By holding a slide thickly spread with any species of the genus Pleurosigma in full sunshine, it is easy to trace the diffraction colours through the various tints of the spectrum from violet to red and even to follow the second diffraction spectrum down to the green, and it is possible in this way to go further than Herr Marpmann would appear to have done so far as can be gathered from the note in question. If a slide of *Pleurosigma angulatum* or *quadratum* is held up in a bright light and a few of the much more coarsely marked *P. balticum* happen to be mixed with the other diatoms, the latter forms, by the different colours which they exhibit, are easily discernible to the naked eye. Two other papers allied to the above are also noted in the same journal, one by Mr. W. Balfour Stokes, who concludes that the minute perforations in *Pleurosigma formosum* are silted up with silica, and one by Mr. J. Rheinberg, who has succeeded, by placing a disc of a certain form above the objective of his microscope, in obtaining two images of the same diatom in complementary colours, one being a dioptric image and the other a diffraction image of the first order.

IN the course of excavating in the churchyard of St. George the Martyr, Southwark, in connection with the Long Lane street improvement, now being carried out by the London County Council, a very interesting discovery has been made. At a depth of about nine feet, some fragments of pottery and of ornamental terra-cotta work were discovered in a heap, as if at some time or other they had been thrown together promiscuously. The fragments were exhibited at a meeting of the Society of Antiquaries on April 17. Whilst the pottery is Roman, the terra-cotta work, the ornamentation of which is peculiar, dates from the time of Henry VIII., in whose reign the art was introduced into England. Stow says that "almost directly over against St. George's Church, was some time a large and most sumptuous house, built by Charles Brandon, late Duke of Suffolk, in the reign of Henry the Eighth, which was called Suffolk House." From Antony van den Wyngaerde's "View of London," circ. A.D. 1550, which contains the only representation of the house known, it appears that the mansion was built in the style of the early Renaissance, and it therefore seems very probable that the fragments in question had their origin in Suffolk House.

THE number of new species of American butterflies, mostly from Brazil, described by Mr. W. Schaus in No. 1262 of the *Proceedings* of the U.S. Museum (vol. xxiv.) may be taken as an indication of the large amount of work which remains to be done in South American entomology.

IN *Naturwissenschaftliche Wochenschrift* of April 27, Mr. C. Frings gives a *résumé* of the experiments made by Dr. Standfuss on hybridising Lepidoptera and the influence of temperature on the development of the pupa, to which allusion has been made in these columns on a previous occasion.

ONE of the most remarkable architectural structures in existence is the left-handed spiral staircase in the Chateau de Blois, Touraine, built during the sixteenth century from designs by Leonardo da Vinci. In a well-illustrated and thoughtful article published in the May number of the *Monthly Review*, Mr. Theodore Cook shows that the design of this staircase corresponds so exactly with the spirals on the common Mediterranean shell known as *Voluta vespertilio* as to leave little doubt that the artist had that shell before him as his model. The spiral on the central column of the core of the staircase corresponds exactly, for instance, with the spiral ridges on the columella of the volute, as seen in section. This of itself would be strong, although perhaps not absolutely convincing, evidence as to the origin of the design. But the staircase has also an exquisite outer balustrade, which shows a correspondence to the coils on the external spire of the shell as close as that which obtains between the interior of the staircase and the columella of the volute. Such a dual resemblance could scarcely be the result of coincidence, and the author seems therefore to be justified in the view he has taken. It is remarkable, however, that the spirals in the staircase run in the reverse direction to those in normal examples of the shell, that of the central shaft being left-handed instead of right-handed. The spirals are, in fact, those of a "reversed," or dextral, example of the shell, of which, perhaps, one in a million occurs in nature. That Leonardo da Vinci had such a reversed shell from which to copy is unlikely; but it is known that he was left-handed, and a left-handed man would naturally draw a reversed spiral. The author, we believe, has in hand a work on natural spirals in general.

THE April number of the *Record of Technical and Secondary Education* contains an important review, by Mr. W. M. Webb, of the means taken by the different County Councils in England for training teachers in the best methods of imparting "nature-knowledge" to their pupils. The prime object of such teaching is, of course, to make the pupils conversant with natural things by seeing and handling them in their own surroundings, and for this purpose field-excursions are absolutely necessary. Some educationists would indeed reserve the American term "nature-study" for observations of this class in which the relationships of animals and plants is not the main point of instruction. But such studies cannot be altogether separated from systematic biology, and the value of a thorough biological groundwork to the teacher is accordingly emphasised by the author. Prof. Bailey's leaflets, which have been adopted by the Board of Education as a basis of nature-study, are insufficient if systematic biology is to be really taught, and short courses on the best methods of teaching natural history

are therefore recommended, and have indeed been adopted by many of the County Councils. Mr. Webb's concluding summary and his observations on methods of training teachers, which are the outcome of many years' practical experience, may be commended to all interested in the subject. Much good is hoped to result from the Nature-Study Exhibition to be held in London in July. Educationists will then "be enabled to compare the results of the efforts to promote 'nature-study' which are now being made in many directions and under varied conditions, and in this way an opportunity will be afforded to shape and to consolidate opinion upon a branch of our educational economy which has escaped hitherto that concentrated attention so necessary for its development."

THE May number of the *Contemporary Review* contains two articles upon scientific subjects. Prof. W. Ramsay describes the present state of our knowledge of different forms of radio-activity and Mr. J. B. Carruthers deals with a subject of a more immediate economic interest, perhaps, viz. plant sanitation. After an explanatory introduction, necessary to introduce the general reader to the terms he afterwards employs, Prof. Ramsay gives a historical sketch of the work done in the direction of perfecting our knowledge of radiation, from the time of Davy down to the present day. He explains the general characteristics of ultra-violet, kathode and X-rays, and proceeds to treat in more detail the work of Poincaré, Henry, Curie, Debierne, Schmidt, Rutherford, Becquerel and others. In conclusion, Prof. Ramsay points the moral upon which NATURE has always insisted—"Whatever be the true explanations of these mysteries, it cannot be denied that they form the beginnings of what may, and almost certainly will, affect the material future of the human race. . . . It is true that investigators like Hertz, Lenard, Becquerel and the Curies do not make practical applications of their discoveries; but there is never any lack of men who discover their practical value and apply them to ends useful to mankind. All the more reason, therefore, that every encouragement should be given to the investigator, for it is to him that all our advances in physical and material well-being are ultimately due." Mr. Carruthers urges that if the same care were taken with plants as has been done to eliminate disease in men and animals, there would be many fewer plant troubles than the agriculturist has to contend with at the present time. He pleads for the introduction into this country of the means taken by the State in America, continental countries and some of our colonies, to discover and eradicate disease in plants.

WE have received the "Year Book of New South Wales," which contains much useful information intended mainly for those wishing to settle in the country. The history, physical features, soils, minerals, water-supplies, trade and commerce, crown lands and many other subjects are dealt with.

THE Yorkshire Geological and Polytechnic Society gives abundant evidence of its flourishing state in the last number of its *Proceedings* (new series, vol. xiv. part ii.), which contains no less than twelve papers and twenty-eight plates. We are glad to note a contribution from the pen of Prof. McKenny Hughes, on the physical geography of the district around Ingleborough. There are papers on glacial drift, on Carboniferous fishes and other subjects, and we may call special attention to a "first paper," by Mr. Robert Kidston, on the flora of the Carboniferous period, illustrated by thirteen excellent photographic plates of coal plants. There is also a memoir, accompanied by a portrait, of the late Mr. W. Percy Sladen.

IN Appendix iv. to the *Kew Bulletin* is given a list of the staffs at the Royal Botanic Gardens, Kew, and at such other botanical establishments at home, in India and the Colonies as are in correspondence with Kew.

WE have received the sixth set (reduced copies) of Blackie's South Kensington drawing cards, which portrays "plant forms" in the shape of leaves, fruits and flowers. Each full-sized set consists of twenty cards, measuring 28 × 20 inches. As the previous set deals with advanced ornament, the present series might with advantage have been more complex; also the comparison of the natural object and the same conventionally treated would have been instructive. As the reduced copies present the objects full size, it would be possible to combine the natural and the conventional on the same card without unduly diminishing the proportions.

THE bibliography of the literature of psychology and cognate subjects, issued annually under the title of the "Psychological Index" by the *Psychological Review*, is a very serviceable publication. The index for 1901, compiled by Prof. H. C. Warren, with the cooperation of Messrs. J. L. des Bancels, L. Hirschlaff, C. D. Isenberg and W. H. R. Rivers, has just been received, and it contains an orderly and comprehensive catalogue of French, German and English psychological publications issued during the year. There are nearly three thousand titles.

THE third edition of Prof. Erdmann's comprehensive "Lehrbuch der anorganischen Chemie" has been published by Messrs. F. Vieweg and Son, Brunswick. The original work was reviewed in these columns nearly three years ago (vol. lx. p. 289), and the new edition does not differ materially from it, though its value has been increased by revision and by the addition of about thirty new pages—bringing the total number up to 788 pages. The first part of the book is concerned with elementary chemical principles and methods, the second with non-metallic elements and the third with the metals. A long section at the end deals with the periodic law and some aspects of physical chemistry.

THE additions to the Zoological Society's Gardens during the past week include a Sooty Mangabey (*Cercocebus fuliginosus*) from West Africa, presented by Miss Frost; a Long-eared Owl (*Asio otus*) European, presented by Miss Kate M. Hall; two Kestrels (*Tinnunculus alaudarius*) British, presented by Mr. Austin; a Black Francolin (*Francolinus vulgaris*) from the Coast of Syria, presented by Commodore Winsloe, H.M.S. *St. George*, a Short Python (*Python curtus*) from Borneo, presented by Mr. L. Wray; a Macaque Monkey (*Macacus cynomolgus*), a Bungoma River Turtle (*Emyda granosa*) from India, two Grey Monitors (*Varanus griseus*) from North Africa, a —— Anaconda (*Eunectes notoeus*), a Western Boa (*Boa occidentalis*) from Paraquay, ten Tessellated Snakes (*Tropidonotus tessellatus*), two Dahl's Snakes (*Zamenis dahli*), a Leopardine Snake (*Coluber leopardinus*), three Æsculapian Snakes (*Coluber longissimus*), a Lacertine Snake (*Coluber monspessulana*), a Dark-green Snake (*Zamenis gemonensis*) European, a Pel's Owl (*Scotopelia peli*) from Africa, a Many-zoned Hawk (*Melierax polyzonus*) from Morocco, deposited; a Brown Capuchin (*Cebus fatuellus*) from Guiana, ten Common Teal (*Querquedula crecca*) European, a Black-pointed Tequexin (*Tupinambis nigropunctatus*) from South America, purchased; a Barbary Wild Sheep (*Ovis tragelaphus*), two Mouflons (*Ovis musimon*), a Rufous-necked Wallaby (*Macropus ruficollis*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

CHANGES ON THE MOON'S SURFACE.—That the moon is a dead planet, devoid of water-vapour and air and consequently lacking any form of life, either of the animal or vegetable world, has long been the belief of astronomers. New light upon the history of our satellite is, however, beginning to dawn, and it seems that the imagination of Mr. H. G. Wells, which illustrated so vividly the seasonal changes on the moon's surface and the appearance of vegetation of rapid growth, is supported by actual

"results of observation," judging from an interesting article by Prof. William H. Pickering in the May number of the *Century Magazine*. Messrs. Pickering and Percival Lowell have during the last few years made numerous excellent observations on the planet Mars, and they have greatly increased our knowledge by accurately observing the surface markings and suggesting very plausible explanations of the phenomena observed. Such work was rendered possible by erecting an observatory in a locality where observing conditions were as near perfect as possible. Prof. Pickering has more recently turned his attention to an examination of the lunar surface, and the first results of this work have led him to some very definite and striking conclusions. The first of these is that there seems to be strong, if not fairly conclusive, evidence in favour of the idea that volcanic activity has not yet entirely ceased, and he quotes several instances in which small craters have disappeared while others have sprung up in different regions. The second, and perhaps more startling, announcement is that there is snow on the moon. He has observed that many craterlets are lined with a white substance which becomes very brilliant when illuminated by the sun, and a similar substance is found on the larger lunar craters and a few of the higher mountain peaks. The curious behaviour of these patches under different angles of illumination and their change of form have led him to suggest that an irregularly varying distribution of hoar frost may have something to do with the changes observed. The third remarkable deduction refers to the observations of "variable spots," which appear to be restricted between latitudes 55° north and 60° south; these spots are always associated with small craterlets or deep narrow clefts, and are often symmetrically arranged around the former. The alterations which these undergo have led him to seek the cause in the change in the nature of the reflecting surface, and the most simple explanation according to him is found in assuming that it is organic life resembling vegetation, but not necessarily identical with it. The new selenography consists, therefore, as Prof. Pickering remarks, "not in mere mapping of cold dead rocks and isolated craters, but in a study of the daily alterations that take place in small selected regions, where we find real, living changes, changes that cannot be explained by shifting shadows or varying librations of the lunar surface." Prof. Pickering illustrates his article with numerous excellent and instructive drawings and photographs of portions of the lunar surface, and these give the reader a good idea of the changes referred to in the text.

DUST-FALLS AND THEIR ORIGINS.[1]

FALLS of dust on a large scale are of rare occurrence, but one very often hears that in the south of Europe at such and such a place rain had fallen and had brought with it, and deposited on the ground, fine red or yellow dust. Thus on April 24, 1897, a south wind carried to southern Italy a great quantity of dust which was supposed to be of African origin.

Perhaps the most well-known instance of a fall on a large scale was that which occurred in May and August in the year 1883, when an enormous quantity of dust was hurled into the air during the Krakatoa eruption, and fell and was collected at various distances, the greatest being more than 1100 miles from the seat of the disturbance. The tremendous height to which the finer particles of dust were thrown, coupled with the movement of the air at this great distance from the earth's surface, were responsible for the magnificent coloured sunsets which were observed nearly all over the world. The volume[2] in which all these observations were collected is undoubtedly one of the most complete records of a "fall of dust" that has been published.

The large number of meteorological stations situated over the greater portion of the civilised world give us now greater chances for recording and tracing the paths of these falls of dust, whether they reach the earth's surface with or without the aid of rain. Fortunately, the tracks of the great dust storm of March 9–12 of last year and that of the minor storm of March 19–21 of the same year were restricted to such regions as these, passing over the coast of northern Africa and reaching Sicily, Italy, Austro-Hungary, Prussia, part of Russia, Denmark and even the British Isles.

In the volume before us, Profs. Hellmann and Meinardus have brought together all the information that could be collected by means of the distribution of circulars and communications with all meteorological stations, and discussed them in a very thorough and able manner, presenting us with a complete story, describing the locality from which the dust came, the means, direction and mode of transport, and finally the places over which it was deposited. The arrangement of the discussion is as follows:—The distribution of the dust over the land surface is first described, accompanied by the original accounts of the phenomenon as observed, a list of all places where the fall was recorded, and a map showing the general distribution. The meteorological conditions from March 9–12 are next dealt with, giving full details of the general atmospheric disturbances over the whole of Europe and North Africa, with numerous maps. The authors then give the individual reports on all the microscopic and chemical analyses of the dust from various localities, concluding with a brief account of the second fall of dust from March 19–21 and a general summary of the main results to which they have been led.

In these chapters the discussion of the facts collected has led the investigators to form a very concrete survey of the whole phenomenon, tracing the origin of the dust to dust-storms that occurred on March 8, 9 and 10 in the desert El Erg, situated in the southern part of Algeria, and which carried the dust and transported it northward.

This dust, as is here pointed out, began to fall at Algiers and Tunis in the dry state on the night of the 9th. The subsequent falls gradually took place northwards, first Sicily, then Italy, the Alps, Austro-Hungary, Germany, Denmark and European Russia, practically in the order named, coming in for their share. In Sicily and Italy the dust was noticed to have fallen even without the aid of rain, but in the other countries it was only detected during and after showers.

Not only did the dust-fall occur in these countries in the sequence mentioned, but the quantity that fell became gradually less the more north the places were situated, and the fineness of the dust, as shown by the analyses, increased at the same time. All these facts, as the authors indicate, are strong arguments in favour of the progress of the dust deposition from south to north, and the very minute and careful examination of the meteorological conditions stated here, showing a depression moving from south to north, endorse this point of view. There is little doubt, therefore, that the locality from which the dust originated was situated somewhere south of the northern shore of the African continent.

It is interesting to notice that the dust was not distributed homogeneously over the land areas, but in patches and streaks, some places, such as, for instance, the greater part of south Germany and Russian Poland, being entirely free from it, while others, such as the southern side of the eastern Alps and Holstein, being specially dense. The unequal distribution and different values for the rate of movement of the dust cloud seem to be adequately explained by the variable velocity of the air currents and the changing position of the barometric depression.

The investigation suggests that the dust was carried by a large mass of air which moved with great velocity from northern Africa to the north of Europe, and that this mass of air, cyclonic in nature, was fed on its western side by air currents from the north and on its eastern side by southerly currents; this accounts for the observed facts that the fall of dust was chiefly limited to the eastern portion of the depression.

As regards the total amount of dust that fell to the surface, rough estimates indicated that the weight of it would amount to about 1,800,000 tons, two-thirds of which were deposited to the south of the Alps.

The authors have shown that the most probable origin of the dust was the region to the south of Algeria, so that an examination of the dust that fell in Europe and elsewhere should consist of similar components as those that form the dust of this region. Nearly all the mineralogical, microscopic and chemical analyses point out that the dust is neither volcanic nor cosmic, but simply such as is found on the African continent. From exactly which part of the continent it came is evidently not certain, for some mineralogists suggested that the dust consisted

[1] "Der grosse Staubfall von 9 bis 12 Marz, 1901, in Nordafrica, Sud- und Mitteleuropa." Von G. Hellmann und W. Meinardus. *Abhandlungen des Königlich Preussischen Meteorologischen Institut*, Bd. ii. No. 1. (Berlin: A. Asher and Co., 1901.)

[2] "Report of the Krakatoa Committee of the Royal Society." (London: Trubner and Co., 1888.)

of the finest particles of Sahara sand, while others looked for its origin on laterite ground.

The value of the occurrences of falls of dust is of special moment meteorologically, because they afford us a means of obtaining further knowledge of the actual movements of the air currents in the higher reaches of our atmosphere which cannot be gained by any other such direct methods. Much valuable information was obtained of the movement of the air at great heights by the dust that was ejected during the eruption of Krakatoa, and as this volcano is situated near the equator, where the air currents have a great tendency to rise directly away from the earth's surface, the conditions were favourable for the dust reaching an extraordinary elevation.

Nevertheless, whether the falls owe their origin to dust storms in a desert or eruptions of large volcanoes, it is of great importance to meteorological science that they should be, not only accurately observed, but recorded and discussed. Fortunately, the fall in the present instance occurred where a great amount of useful data could be, and was, secured. In the handling of this material the authors are to be congratulated, for besides considerably increasing our knowledge of the way in which the dust is transported and enlightening us on other peculiarities of this interesting phenomenon, they have given us a volume which will serve as an excellent example for future recorders and observers. W. J. S. L.

BRITISH VERSUS AMERICAN LOCOMOTIVES.

A NOTEWORTHY Parlimentary paper has recently been issued containing correspondence respecting the comparative merits of British, Belgian and American built locomotives running on the Egyptian railways. The paper is full of interest to the locomotive engineer, bearing out as it does the unsatisfactory results obtained with American locomotives on British, Colonial and Indian railways when compared with the English design of engine, and, what is more, these unsatisfactory results are in all cases certified by the representative of the American firm of locomotive builders, as well as by an official appointed by the Egyptian railway authority, so there can be little doubt as to their accuracy.

Probably the most interesting report in the series is that by Mr. Trevithick, the locomotive engineer, who says:—

"The Mechanical Department of the Egyptian State Railways has recently made some interesting comparative trials between British and American locomotives of the same weight and power. These comparisons have been carried out under exceptionally favourable circumstances, inasmuch as the locomotives employed were typical of their respective countries in design and manufacture, and the trials were personally conducted, and the results conjointly signed, by a representative sent out by the American builders and a locomotive inspector of the Egyptian Railway Administration.

"The first set of trials, consisting of eight runs extending over 1034 miles, was between goods engines, and, in order to secure similar loads and to be able to gradually increase the weight of trains to the maximum that the respective engines could satisfactorily draw, the material transported consisted chiefly of coal.

"The total amount of coal consumed in the eight trips by the British engines was 22·84 tons, which works out at an average of 49·4lbs. per mile, whilst the American engines consumed 28·69 tons, an average of 62 lbs. per mile; in other words, for every 100 tons of coal consumed by the British engines the American engines burnt 125·4 tons, *i.e.* an excess of 25·4 per cent. This economy was effected by the British engines, although they drew a heavier average load, to the extent of 14·2 per cent. than the American, the average train taken by the British engines being 57 trucks, or 868 tons, as against 54 trucks, or 760 tons, the average train taken by the American. The maximum load taken by each make of engine was 61 trucks.

"These trials were followed by others between passenger types of engines, extending over 1345 miles; each make ran an equal number of trips with practically similar formation of trains, with the result that the British engines consumed a total of 18·47 tons of coal, or an average of 30·7 lbs. per mile, as against a total of 27·8 tons, or an average of 46·3 lbs. per mile, in the case of the American engines, which means that where the British engine consumed 100 tons, the American engine consumed 150 tons, or 50 per cent. more. Such a difference at 1*l.* 14*s.* 2*d.* per ton, the average price paid last year by the Railway Administration, represents an additional yearly cost per engine of 400*l.*; which is to say that these ten American engines would cost in coal in one year 4000*l.* more than the ten British engines, an amount almost sufficient to buy two new ones."

The above extract from Mr. Trevithick's report conclusively proves that the British type of locomotive is well able to hold its own in the three important matters of fuel and oil consumption, and cost of repairs. Much has been written lately on the standardisation of the locomotive, but in a progressive age this appears to be unnecessary, since the locomotive of yesterday must always be out of date. Much can, however, be done to assist locomotive builders in the way of standardisation of specifications and, more particularly, of the test requirements for the material.

It is absurd to think that consulting engineers cannot agree as to the best test requirements for, say, a crank axle or a steel boiler plate. With standard tests the locomotive builders could buy the material more cheaply, obtain quicker deliveries from the makers, and, probably, in their turn take less time to complete an order.

INTERFERENCE OF SOUND.[1]

FOR the purposes of laboratory or lecture experiments it is convenient to use a pitch so high that the sounds are nearly or altogether inaudible. The wave-lengths (1 to 3 cm.) are then tolerably small, and it becomes possible to imitate many interesting optical phenomena. The ear as the percipient is replaced by the high-pressure sensitive flame, introduced for this purpose by Tyndall, with the advantage that the effects are visible to a large audience.

As a source of sound a "bird-call" is usually convenient. A stream of air from a circular hole in a thin plate impinges centrically upon a similar hole in a parallel plate held at a little distance. Bird-calls are very easily made. The first plate, of 1 or 2 cm. in diameter, is cemented, or soldered, to the end of a short supply tube. The second plate may conveniently be made triangular, the turned-down corners being soldered to the first plate. For calls of medium pitch the holes may be made in tin plate. They may be as small as ½ mm. in diameter, and the distance between them as little as 1 mm. In any case the edges of the holes should be sharp and clean. There is no difficulty in obtaining wave-lengths (complete) as low as 1 cm., and with care wave-lengths of 0·6 cm. may be reached, corresponding to about 50,000 vibrations per second. In experimenting upon minimum wave-lengths, the distance between the call and the flame should not exceed 50 cm., and the flame should be adjusted to the verge of flaring ("Theory of Sound," 2nd ed., § 371). As most bird-calls are very dependent upon the precise pressure of the wind, a manometer in immediate connection is practically a necessity. The pressure, originally somewhat in excess, may be controlled by a screw pinch-cock operating on a rubber connecting tube.

In the experiments with conical horns or trumpets, it is important that no sound should issue except through these channels. The horns end in short lengths of brass tubing which fit tightly to a short length of tubing (A) soldered air-tight on the face of the front plate of the bird-call. So far there is no difficulty; but if the space between the plates be boxed in air-tight, the action of the call is interfered with. To meet this objection a tin-plate box is soldered air-tight to A, and is stuffed with cotton-wool kept in position by a *loosely* fitting lid at C. In this way very little sound can escape except through the tube A, and yet the call speaks much as usual. The manometer is connected at the side tube D. The wind is best supplied from a gas-holder.

With the steadily maintained sound of the bird-call there is no difficulty in measuring accurately the wave-lengths by the method of nodes and loops. A glass plate behind the flame, and mounted so as to be capable of sliding backwards and forwards, serves as reflecting wall. At the plate, and at any distance from it measured by an *even* number of quarter wave-lengths, there are nodes, where the flame does not respond. At intermediate distances, equal to *odd* multiples of the quarter wave-length, the effect upon the flame is a maximum. For the present purpose it is best to use nodes, so adjusting the sensitiveness of the flame that it only just recovers its height at the

[1] A Discourse delivered at the Royal Institution on Friday, January 17, by the Right Hon. Lord Rayleigh, F.R.S.

minimum. The movement of the screen required to pass over ten intervals from minimum to minimum may be measured, and gives at once the length of five complete progressive waves. For the bird-call used in the experiments of this lecture the wave-length is 2 cm. very nearly.

When the sound the wave-length of which is required is not maintained, the application of the method is, of course, more difficult. Nevertheless, results of considerable accuracy may be arrived at. A steel bar, about 22 cm. long, was so mounted as to be struck longitudinally every two or three seconds by a small hammer. Although in every position the flame shows some uneasiness at the stroke of the hammer, the distinction of loops and nodes is perfectly evident, and the measurement of wave-length can be effected with an accuracy of about 1 per cent. In the actual experiment the wave-length was nearly 3 cm.

The formation of stationary waves with nodes and loops by perpendicular reflection illustrates interference to a certain extent, but for the full development of the phenomenon the interfering sounds should be travelling in the same, or nearly the same, direction. The next example illustrates the theory of Huyghens' zones. Between the bird-call and the flame is placed a glass screen perforated with a circular hole. The size of the hole, the distances and the wave-length are so related to one another that the aperture just includes the first and second zones. The operation of the sounds passing these zones is antagonistic, and the flame shows no response until a part of the aperture is

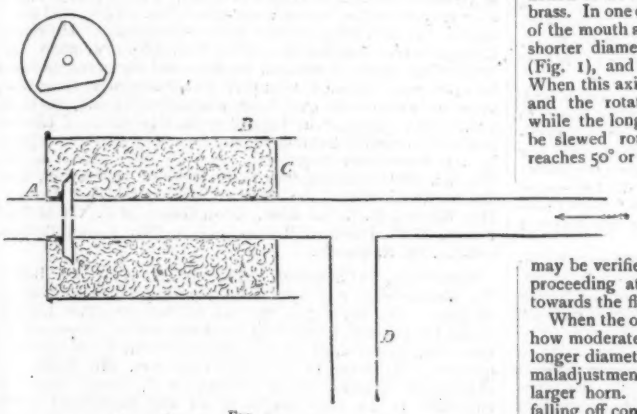


FIG. 1.

blocked off. The part blocked off may be either the central circle or the annular region defined as the second zone. In either case the flame flares, affording complete proof of interference of the parts of the sound transmitted by the aperture.

From a practical point of view, the passage of sound through apertures in walls is not of importance, but similar considerations apply to its issue from the mouths of horns, at least when the diameter of the mouth exceeds the half wave-length. The various parts of the sound are approximately in the same phase when they leave the aperture, but the effect upon an observer depends upon the phases of the sounds, not as they leave, but as they arrive. If one part has further to go than another, a phase discrepancy sets in. To a point in the axis of the horn, supposed to be directed horizontally, the distances to be travelled are the same, so that here the full effect is produced, but in oblique directions it is otherwise. When the obliquity is such that the nearest and furthest parts of the mouth differ in distance by rather more than one complete wave-length, the sound may disappear altogether through antagonism of equal and opposite effects. In practice the attainment of a complete silence would be interfered with by reflections, and in many cases by a composite character of sound, viz. by the simultaneous occurrence of more than one wave-length.

In the fog signals established on our coasts, the sound of powerful sirens issues from conical horns of circular cross-section. The influence of obliquity is usually very marked. When the sound is observed from a sufficient distance at sea, a deviation of even 20° from the axial line entails a considerable loss, to be further increased as the deviation rises to 40° or 60°. The difficulty thence arising is met, in the practice of the Trinity House, by the use of two distinct sirens and horns, the axes of the latter being inclined to one another at 120°. In this way an arc of 180° or more can be efficiently guarded, but a more equable distribution of the sound from a single horn remains a desideratum.

Guided by the considerations already explained, I ventured to recommend to the Trinity House the construction of horns of novel design, in which an attempt should be made to spread the sound out horizontally over the sea, and to prevent so much of it from being lost in an upward direction. The solution of the problem is found in a departure from the usual circular section and the substitution of an elliptical or elongated section, of which the short diameter, placed horizontally, does not exceed the half wave-length; while the long diameter, placed vertically, may amount to two wave-lengths or more. Obliquity in the *horizontal plane* does not now entail much difference of phase, but when the horizontal plane is departed from, such differences enter rapidly.

Horns upon this principle were constructed under the supervision of Mr. Matthews, and were tried in the course of the recent experiments off St. Catherine's. The results were considered promising, but want of time and the numerous obstacles which beset large-scale operations prevented an exhaustive examination.

On a laboratory scale there is no difficulty in illustrating the action of the elliptical horns. They may be made of thin sheet brass. In one case the total length is 20 cm., while the dimensions of the mouth are 5 cm. for the long diameter and 1¼ cm. for the shorter diameter. The horn is fitted at its narrow end to A (Fig. 1), and can rotate about the common horizontal axis. When this axis is pointed directly at the flame, flaring ensues; and the rotation of the horn has no visible effect. If now, while the long diameter of the section remains vertical, the axis be slewed round in the horizontal plane until the obliquity reaches 50° or 60°, there is no important falling off in the response of the flame. But if at obliquities exceeding 20° or 30° the horn is rotated through a right angle, so as to bring the long diameter horizontal, the flame recovers as if the horn had ceased sounding. The fact that there is really no falling off may be verified with the aid of a reflector, by which the sound proceeding at first in the direction of the axis may be sent towards the flame.

When the obliquity is 60° or 70°, it is of great interest to observe how moderate a departure from the vertical adjustment of the longer diameter causes a cessation of effect. The influence of maladjustment is shown even more strikingly in the case of a larger horn. According to theory and observation, a serious falling off commences when the tilt is such that the difference of distances from the flame of the two extremities of the long diameter reaches the half wave-length—in this case 1 cm. It is thus abundantly proved that the sound issuing from the properly adjusted elliptical cone is confined to a comparatively narrow belt round the horizontal plane and that in this plane it covers efficiently an arc of 150° or 160°.

Another experiment, very easily executed with the apparatus already described, illustrates what are known in optics as Lloyd's bands. These bands are formed by the interference of the direct vibration with its very oblique reflection. If the bird-call is pointed toward the flame, flaring ensues. It is only necessary to hold a long board horizontally under the direct line to obtain a reflection. The effect depends upon the precise height at which the board is held. In some positions the direct and reflected vibrations cooperate at the flame, and the flaring is more pronounced than when the board is away. In other positions the waves are antagonistic, and the flame recovers as if no sound were reaching it at all. This experiment was made many years ago by Tyndall, who instituted it in order to explain the very puzzling phenomenon of the "silent area." In listening to fog-signals from the sea it is not unfrequently found that the signal is lost at a distance of a mile or two and recovered at a greater distance in the same direction. During the recent experiments, the Committee of the Elder Brethren of the Trinity House had several opportunities of making this observation. That the surface of the sea must act in the manner supposed by Tyndall cannot be doubted, but there are two difficulties in the way of accepting the simple explanation as complete. According to it the interference should always be the same, which is

certainly not the case. Usually there is no silent area. Again, although according to the analogy of Lloyd's bands there might be a dark or silent place at a particular height above the water, say on the bridge of the *Irene*, the effect should be limited to the neighbourhood of the particular height. At a height above the water twice as great, or near the water level itself, the sound should be heard again. In the latter case there were some difficulties, arising from disturbing noises, in making a satisfactory trial; but as a matter of fact, neither by an observer up the mast nor by one near the water level was a sound lost on the bridge ever recovered.

The interference bands of Fresnel's experiment may be imitated by a bifurcation of the sound issuing from A (Fig. 1). For this purpose a sort of T-tube is fitted, the free ends being provided with small elliptical cones, similar to that already described, the axes of which are parallel and distant from one another by about 40 cm. The whole is constructed with regard to symmetry, so that sounds of equal intensity and of the same phase issue from the two cones the long diameters of which are vertical. If the distances of the burner from the mouths of the cones be precisely equal, the sounds arrive in the same phase and the flame flares vigorously. If, as by the hand held between, one of the sounds is cut off the flaring is reduced, showing that with this adjustment the two sounds are more powerful than one. By an almost imperceptible slewing round of the apparatus on its base-board, the adjustment above spoken of is upset and the flame is induced to recover its tall equilibrium condition. The sounds now reach the flame in opposition of phase and practically neutralise one another. That this is so is proved in a moment. If the hand be introduced between either orifice and the flame, flaring ensues, the sound not intercepted being free to produce its proper effect.

The analogy with Fresnel's bands would be most complete if we kept the sources of sound at rest and caused the burner to move transversely so as to occupy in succession places of maximum and minimum effect. It is more convenient with our apparatus and comes to the same thing, if we keep the burner fixed and move the sources transversely, sliding the base-board without rotation. In this way we may verify the formula, connecting the width of a band with the wave-length and the other geometrical data of the experiment.

The phase discrepancy necessary for interference may be introduced, without disturbing the equality of distances, by inserting in the path of one of the sounds a layer of gas having different acoustical properties from air. In the lecture carbonic acid was employed. This gas is about half as heavy again as air, so that the velocity of sound is less in the proportion of 1:1·25. If l be the thickness of the layer, the *retardation* is $\cdot 25\,l$; and if this be equal to the half wave-length, the interposition of the layer causes a transition from complete agreement to complete opposition of phase. Two cells of tin plate were employed, fitted with tubes above and below, and closed with films of collodion. The films most convenient for this purpose are those formed upon water by the evaporation of a few drops of a solution of celluloid in pear-oil. These cells were placed one in the path of each sound, and the distances of the cones adjusted to maximum flaring. The insertion of carbonic acid into *one* cell quieted the flame, which flared again when the second cell was charged so as to restore symmetry. Similar effects were produced as the gas was allowed to run out at the lower tubes, so as to be replaced by air entering above.[1]

Many vibrating bodies give rise to sounds which are powerful in some directions but fail in others—a phenomenon that may be regarded as due to interference. The case of tuning forks (unmounted) is well known. In the lecture a small and thick wine-glass was vibrated, after the manner of a bell, with the aid of a violin bow. When any one of the four vibrating segments was presented to the flame, flaring ensued; but the response failed when the glass was so held at the same distance that its *axis* pointed to the flame. In this position the effects of adjacent segments neutralise one another and the aggregate is zero. Another example, which, strangely enough, does not appear to have been noticed, is afforded by the familiar open organ pipe. The vibrations issuing from the two ends are in the same phase as they start, so that if the two ends are equally distant from the percipient, the effects conspire. If, however, the pipe be pointed towards the percipient, there is a great falling off, inasmuch as the length of the pipe approximates to the half wave-length of the sound. The experiment may be made in the lecture-room with the sensitive flame and one of the highest pipes of an organ, but it succeeds better and is more striking when carried out in the open air with a pipe of lower pitch, simply listened to with the unaided ear of the observer. Within doors reflections complicate all experiments of this kind.

[1] In a still atmosphere the hot gases arising from lighted candles may be substituted for the layers of CO_2.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The 235th meeting of the Junior Scientific Club was held on May 2 in the physiological lecture room at the Museum. Two papers were read, "A New Type of Vertebrate Kidney," by Mr. E. S. Goodrich, Merton College, and "The Prussic Acid Problem," by Mr. J. M. Wadmore, Trinity College.

The ninth Robert Boyle lecture of the Junior Scientific Club will be delivered by Prof. T. Clifford Allbutt, F.R.S., in Balliol College Hall on Tuesday next, May 13. The subject will be "The Growth of the Experimental Method in Oxford."

THE honorary degree of LL.D. was conferred on Lord Kelvin on Monday by the University of Yale.

A MEETING will be held at the Mansion House to-morrow, May 9, at 3 p.m., with the Lord Mayor in the chair, in support of higher university education and research in London, with special reference to the fund being raised for the endowment of University College and its incorporation in the University of London. All who are interested in national progress and the advancement of knowledge are invited to take part in this movement for making up in some degree the gaps in our educational system, and in the endeavour to place at the disposal of the inhabitants of London facilities for mental training at any rate equal to those enjoyed by our continental neighbours. Among the speakers at the Mansion House meeting will be the Duke of Devonshire, Lord Brassey (chairman of the Appeal Committee), Lord Avebury, Mr. Ritchie, M.P., the Hon. Alban Gibbs, M.P., Sir Michael Foster, M.P., Principal Rücker, F.R.S., Mr. Lionel Phillips, and Mr. H. R. Beeton.

THE debate on the second reading of the Education Bill of the Government was opened in the House of Commons on Monday. Mr. Bryce gave reasons for believing that the Bill would not establish satisfactory local authorities, secure educational improvement, or effect a final settlement of the education question. Referring to secondary education, Mr. Bryce said that the Bill promises to do nothing for it, though secondary education is the most urgent of all our educational wants. "It does not direct any inquiry or any scheme to be made for the reorganisation of secondary education. It does not impose any duty upon the new authorities to provide secondary education, however great the local need may be. It is purely permissive. It does not contain any suggestion for dealing with endowments or for the reorganisation of schools. It does not set apart the grant under the Act of 1890 as only applicable to secondary education. It gives a rating power up to 2*d.*, with the possibility of increase by the consent of the Local Government Board. Secondary education ought to have had a Bill to itself, and it ought to have had a start of two or three years before primary education is thrown upon the same authority, if ever it is to be thrown upon it. Now, the probability is that secondary education will go to the wall." Sir John Gorst urged in reply that the Bill creates an authority, or it gives to the authority already existing for technical education full powers for secondary education, and so may be said to do something for secondary education. As to the inadequacy of the funds available under the Bill, it was held that the County Councils had enough to begin with, "and," added Sir John Gorst, "if this Bill is passed it will, at all events, make a beginning of secondary education, and when the authorities of counties and county boroughs see what sum of money is really required, I have no doubt the representations made by them to this House will be received with very fair consideration." The debate was continued on Tuesday, and among the points discussed were the comparative merits of School Boards and County Councils as local authorities for education, need for better training of teachers, the extension of the limit of a 2*d.* rate, and the need for generous grants from the Exchequer for secondary education.

THERE will be an exhibition of scientific apparatus at the conference of science teachers to be held at Festiniog on May 15 (see p. 599, April 24). Good apparatus is urgently required in many Welsh schools, and manufacturers ought to hasten to avail themselves of the opportunity which the conference affords of exhibiting instruments and materials essential to practical instruction in science. Mr. J. Griffith, County School, Festiniog, has entire charge of the exhibition arrangements, and would provide rooms and allocate space for the display of scientific apparatus.

THE Technical Education Board of the London County Council will shortly award five senior county scholarships. The scholarships are open to young men and young women who are resident within the administrative county of London whose parents are in receipt of an income not exceeding 400*l.* a year. They are tenable for three years at British or foreign Universities and technical colleges of University rank, and are of the value of 90*l.* a year. Candidates should as a rule be not more than twenty-two years of age, preference being given to those who are under nineteen years of age. In addition to the scholarships, the Board offers for competition a limited number of free places at the principal London colleges. Application forms can be obtained from the secretary of the Technical Education Board, and must be returned not later than Monday next, May 12.

A MEETING of the Association of Technical Institutions will be held between the second reading of the Government Education Bill and the Committee stage. At this meeting the council will recommend the Association to adopt the following resolutions in regard to the Bill:—(1) That this Association cordially approves the general principles upon which the Government Education Bill is based, and strongly urges His Majesty's Government to pass the Bill in the present session of Parliament. (2) That this Association is strongly of opinion that the new local authorities should be responsible for all grades of education in their districts, and that proper educational co-ordination would be seriously and unnecessarily hindered if this principle were not adopted; it therefore urges the Government to amend the Bill by deleting the clauses making it optional for the County and Borough Councils to undertake the supervision of elementary education. (3) That this Association regrets to note that the Bill makes optional the application to the purposes of higher education of the residue under the Local Taxation (Customs and Excise) Act, 1890, and it requests the Government to make such application compulsory. (4) That this Association regrets the exclusion of London from the Bill and trusts that the metropolis may receive attention early next year, and, while recognising that the case of London requires special treatment, is of opinion that it would be unwise to depart from the general principles of the present Bill in the case of London.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 12, 1901.—"On the Action of the Spurge (*Euphorbia hiberna*, L.) on Salmonoid Fishes." By H. M. Kyle, M.A., D.Sc., St. Andrews University. Communicated by Prof. McIntosh, F.R.S.

It has been known for some years that the Irish peasantry employed a simple method of procuring salmon and trout through the agency of the Spurge (*E. hiberna*, L.). The plant cut into small pieces and pounded with stones, or simply trampled upon at some convenient spot on a river, forms an emulsion in the water which, being swept downward into the pools, carries death to all fishes in its course. The fatality thus produced seems to have been enormous—80 to 100 salmon are reported to have been killed at one time, and again in the Bandon rivers 500 to 1000 fish of various descriptions are said to have been poisoned during one season. In the light of the experiments to be recorded presently, these statements do not seem exaggerated, for the Spurge-extract, even in small quantities, is almost as fatal to fishes as corrosive sublimate.

The fatal effect of the Spurge on fishes has been known in other countries besides Ireland, but to what ingredient or ingredients of the plant these effects are due seems never to have been investigated. The experiments described in the present paper throw considerable light upon the action of the Spurge, and open out to view some interesting problems.

Chemical analysis of the Spurge-extract shows that it contains tannic acid. Experiments on the circulation in the lung and mesentery of the frog reveal a close similarity between the action of the Spurge-extract and of tannic acid. In the case of trout the similarity extends to the non-recovery of the fish in fresh water, after they have come under the influence of either Spurge-extract or tannic acid. The power of the Spurge-extract to produce fatal effects persists for several days without diminution. Twenty per cent. of the fresh extract is fatal within five minutes, whilst 0·01 per cent. takes 4 to 6 hours, and seems to be the smallest percentage which has fatal results. In the case of fishes, death is considered to ensue from the inflammation of the gills and consequent stasis of the circulation, set up by the action of the tannic-acid component of the Spurge-extract. The fresh extract is calculated roughly to contain about 1 per cent. of tannic acid, but on this estimation the Spurge-extract is fatal within a shorter period than the corresponding quantity of tannic acid. Hence, the percentage of tannic acid has been under-estimated, or some other substance or substances in the extract also aid in producing fatal effects.

March 20.—"Persulphuric Acids." By Prof. Henry E. Armstrong, V.P.R.S., and T. Martin Lowry, D.Sc.

The "remarkable disappearance of oxygen" which Faraday, in 1834, observed to take place on electrolysing strong solutions of sulphuric acid was shown by Berthelot, in 1878, to be due mainly to peroxidation of the sulphuric acid. An anhydride, S_2O_7, was isolated, and he therefore concluded that the corresponding per*di*sulphuric acid, $H_2S_2O_8$, was formed when sulphuric acid was peroxidised either by anode oxidation or by interaction with hydrogen peroxide. The per*di*sulphates were isolated by Marshall, in 1891, by electrolysing solutions of acid sulphates, and have found a technical application in photography. This simple explanation of the peroxidation of sulphuric acid remained unchallenged until Caro found, in 1898, that when the per*di*sulphates are dissolved in sulphuric acid and the solution is again neutralised, a product is obtained which possesses the property of oxidising aniline to nitrosobenzene. None of the salts of Caro's modified persulphuric acid have yet been isolated, and only indirect methods are therefore available for determining its constitution.

Von Baeyer and Villiger have determined the ratio of sulphur to active oxygen in a solution containing the barium salt of Caro's acid, and found the ratio to be $SO_3 : O = 1 : 1$, the ratio for Marshall's salts being $SO_3 : O = 2 : 1$. They therefore assigned to Caro's acid the formula H_2SO_5 of a per*mono*sulphuric acid. If this acid be dibasic its salts must remain neutral when reduced, thus $CaSO_5 = CaSO_4 + O$, whereas any higher member of the series would liberate acid, thus $CaS_2O_8 + H_2O = CaSO_4 + H_2SO_4 + O$. Caro's salts are extremely unstable in presence of caustic alkalis, but neutral solutions can be prepared by neutralising with carbonates; when such solutions are heated they lose their active oxygen and liberate acid in the ratio $H_2SO_4 : O_2$. This result can only be reconciled with the formula of von Baeyer and Villiger by assuming per*mono*sulphuric acid to be monobasic, $NaHSO_5 = NaHSO_4 + O$; a more probable view is that Caro's acid is the *anhydro*-acid, $O\begin{<}^{SO_2.O.OH}_{SO_2.O.OH}$, and that its salts are comparable with the *pyro*sulphates and the *di*chromates, $CaS_2O_9 + H_2O = CaSO_4 + H_2SO_4 + O_2$.

In concentrated solutions containing less than 50 per cent. of water, the peroxidation of sulphuric acid proceeds differently, the chief product being probably a per*tetra*sulphuric acid, $H_2S_4O_{14}$ (Lowry and West, Chem. Soc. *Trans.*, 1900, 950). This acid, the fourth member of the series $H_2O_2.nSO_3$, bears to pyrosulphuric acid the same relationship as that which per*di*sulphuric acid bears to sulphuric acid, $2H_2S_2O_7 - H_2 = H_2S_4O_{14}$, $2H_2SO_4 - H_2 = H_2S_2O_8$. On dilution and neutralisation it is hydrolysed to a salt of Caro's acid.

At the present time it is therefore necessary to postulate the existence of at least three persulphuric acids, in which the ratio $SO_3 : O$ is 1:1, 1 : 2 and 1 : 4 respectively. In spite of the stability of the perdisulphates, the least stable of these is per*di*sulphuric acid, for when liberated from its salts it rapidly passes in dilute solution to a per*mono*sulphuric acid (Caro's acid), whilst in presence of concentrated sulphuric acid it is converted mainly into per*tetra*sulphuric acid.

"On a Throw-testing Machine for Reversals of Mean Stress." By Osborne Reynolds, F.R.S., and J. H. Smith, M.Sc.

This research was undertaken at the suggestion of Prof.

Osborne Reynolds, who proposed an investigation of "repeated stress" on the following lines:—The stress should be direct tension, and compression of approximately equal amounts, such tension and compression being obtained by means of the inertia force of an oscillatory weight. The rapidity of repetitions should be much higher than in the experiments of Wöhler, Spangenberg, Bauschinger and Baker—in fact, ranging as high as 2000 reversals per minute.

The conclusions arrived at are:—

(1) The reversals for rupture with a given range of stress diminish as the periodicity of the reversals increases.

(2) The hard steels will not withstand a greater number of reversals of the same range of stress than the mild steels if the periodicity of the reversals is great.

Zoological Society, April 15.—Prof. G. B. Howes, F.R.S., vice-president, in the chair.—On behalf of Prof. F. Jeffrey Bell were exhibited two arms of an injured starfish of the genus Luidia from the west coast of Ireland, which had undergone repair at their ends. These regenerated parts were unlike the rest of the arm and had a striking, though not exact, resemblance to the free ends of the arms of an Astropecten.—Dr. Forsyth Major exhibited some selected specimens from a collection of fossil bones recently received by the Natural History Museum from Cyprus, where they had been discovered in caves by Miss Dorothy M. A. Bate. The remains proved to be those of a pigmy hippopotamus, about half the size of *Hippopotamus amphibius*, and could not be distinguished from Cuvier's "Petit *Hippopotame fossile*" (*H. minutus*, Blainv.), which was smaller than the so-called "*H. minutus*" from Malta, and otherwise different. The fossils exhibited showed affinities on the one hand with the pigmy hippopotamus of Western Africa, "*Chocropsis liberiensis*," on the other with some remains from the Lower Pliocene of Casino (Italy); they were considered by the exhibitor as a further illustration of the assumption that many of the Pleistocene mammals of the Mediterranean islands were the little-modified survivors of Tertiary forms from the adjoining continents, from which the islands had been severed during the Tertiary period.—Mr. W. P. Pycraft read the fifth part of his "Contributions to the Osteology of Birds," which dealt with the Falconiformes.—Mr. F. E. Beddard, F.R.S., read a paper dealing with the sexual differences observed in the windpipe of the condor. It also treated of a rudimentary equivalent of the septal flap of the right auriculo-ventricular valve met with in the hearts of that bird and of a form of cuckoo (Scythrops).—A paper by Mr. Hesketh Prichard, on the larger mammals of Patagonia, contained field-notes on the huemul (*Xenelaphus bisulcus*), the puma (*Felis concolor*), Pearson's puma (*Felis concolor pearsoni*), the Patagonian cavy (*Cavia patagonica*), and the guanaco. The extraordinary tameness of the huemul was dwelt upon. The habits of the grey puma (*Felis concolor*) were described, a contrast being pointed out between their method of killing their prey and that of the jaguar (*Felis onca*). Pearson's puma, a new subspecies of puma, was alluded to as being much rarer than the grey puma, smaller, fiercer, and in colour reddish at the extremities. The fact of the distribution of the cavy (*Cavia patagonica*) being arbitrarily limited in the neighbourhood of the 45th parallel of latitude was commented upon as being strange, inasmuch as there was no change either in the vegetation or in the nature of the ground to account for it.—Mr. F. Pickard Cambridge read a paper on the spiders of the genus Latrodectus, which had a universally bad reputation of being extremely venomous in various parts of the world, although more exact evidence was required on this question. A list of the recognised species and subspecies was given.—A paper by Mr. Frank Finn contained some notes on the painted snipe (*Rostratula capensis*) and the pheasant-tailed jacana (*Hydrophasianus chirurgus*), of which birds he had recently presented some specimens to the Society's Gardens.—A paper by Mr. G. A. Boulenger, F.R.S., contained descriptions of eight new species of fishes from the Congo, forming part of a collection entrusted to him for study by the Director of the Royal Museum of Natural History in Brussels. The paper also contained a list of forty-one species of fishes from the Lindi River, Upper Congo, collected by M. Maurice Storms for the Brussels Museum.

Entomological Society, April 16.—The Rev. Canon Fowler, president, in the chair.—Mr. O. E. Jansen exhibited specimens of both sexes of *Ornithoptera victoriae* from Ysabel, Solomon Islands, recently taken by Mr. Albert Meek, and remarked on the variation in the colour and markings in the males.—Mr. H. W. Shepheard-Walwyn exhibited a series of *Euchelia jacobaeae* taken by him at Winchester in July 1889, showing considerable variations of size and colouring.—Mr. Willoughby Gardner exhibited *Coelioxys mandibularis*, Nyl., from the Cheshire coast, a species new to Britain; and *Osmia xanthomelana*, ♂ and ♀, and *Osmia parietina*, Curt., ♂ and ♀, from North Wales.—Mr. A. J. Chitty exhibited a specimen of *Aglais urticae* taken at sallow on March 28, having a large portion of the hind wings cut off so that when folded they were symmetrical in outline. From their appearance he concluded they had been bitten off by some animal, probably during hibernation.—Dr. T. A. Chapman called attention to the remarkable bilateral asymmetry in the male appendages of the Hemarid Sphinx, *Cephonodus hylas*, Linn. He said that bilateral asymmetry in insects was sufficiently rare to make it always notable. In the male apophyses of Lepidoptera he had only been able to find records in the case of the Hesperid genus Thanaos, to which Scudder and Burgess first called attention—though it seems highly probable that the facts can hardly have been unobserved in so common a species as *C. hylas*. He also exhibited specimens of the appendage removed from the insect, and of the several parts, as well as sketches of the clasps and tegumen.—Mr. C. P. Pickett exhibited many varieties and forms of *Hybernia leucophaearia* taken during March at Chingford, Highgate and Finchley. He also showed series of *Phigalia pedaria*, *Anisopteryx aescularia* and *Nyssia hispidaria* from the north metropolitan district.—Mr. H. J. Turner, on behalf of Mr. W. West, of Greenwich, exhibited specimens, ♂s and ♀s, of *Stictocoris flaveola*, Bohm., a species new to the British fauna, found amongst long grass in damp places at Lee, Kidbrook and Shooter's Hill, also several specimens of *Typhlocyba candidula*, Kir., a species first discovered by Mr. West at Lewisham and Blackheath on *Populus alba*.—Dr. D. Sharp communicated a paper by Miss Alice L. Embleton on the economic importance of the parasites of Coccidæ.—Colonel Charles Swinhoe read a paper entitled "Eastern and Australian Drepanulidæ, Epiplemidæ, Microniidæ and Geometridæ in the British Museum collection.—Mr. W. F. Kirby contributed a paper entitled "Additional Notes on Mr. Distant's Collection of African Locustidæ."

Royal Microscopical Society, April 16.—Dr. Hy. Woodward, F.R.S., president, in the chair.—A pocket microscope was presented on behalf of Mr. Jacob Pillischer. It was made by his uncle, Mr. M. Pillischer, and is described and figured in Dr. Golding Bird's work on "Urinary Deposits" (5th ed., 1857). The design is most ingenious. A small stage plate for carrying a 3″ × 1″ slide forms the base of the instrument; attached below to a jointed arm is a plane mirror and a diaphragm with suitable apertures. Above the plate and at one corner is a pillar carrying an arm, which reaches to the centre of the stage, for holding the lenses, which are Coddingtons of ½, $\frac{1}{10}$, $\frac{1}{20}$ inch foci; the pillar contains a direct acting screw fine adjustment. The whole packs in a small case, which can be carried in the waistcoat pocket. With achromatic lenses it is a pattern which might have its uses at the present day.—Mr. C. Beck exhibited and described Standing's embedding microtome, an ingenious and simple hand microtome designed for cutting botanical sections, and extremely cheap. Mr. Beck also directed attention to some exceedingly fine rulings on glass, ruled by Mr. Grayson, of Melbourne. They had been brought from Australia by Mr. Wedeles, and were exhibited in the room. They were mounted in realgar, a medium having a refractive index of 2·5, which added considerably to the distinctness with which the lines could be seen. Three examples were exhibited, one being a micrometer divided into $\frac{1}{10}$ths and $\frac{1}{100}$ths of an inch, and fourths, tenths and hundredths of a millimetre, another, a test plate of ten bands varying from 1000 to 10,000 lines to the inch, and another of twelve bands varying from 5000 to 60,000 lines to the inch. Mr. Wedeles stated that Mr. Grayson had ruled bands up to 120,000 lines to the inch.—Mr. J. C. Webb exhibited an old microscope by Pritchard the date of which he was unable to give, but thought it probably anterior to the advent of the engiscope which Pritchard brought out in 1832. The principal features of the instrument were a device for protecting the objective from injury when focussing—the first eyepiece was triple, it admitted plenty of light, and gave a good field with low powers. There was a fine adjustment to the nose-piece, and the body could be removed and the instrument used as a dissecting microscope.—Mr. Ersser ex-

hibited a reversible live box intended for use in observing large living objects, such as spiders while spinning their webs. —Messrs. Powell and Lealand exhibited a new $\frac{1}{12}$-inch semi-apochromatic homogeneous immersion objective of 1·4 N.A. It was made of glass which would stand any climate without deterioration, and the cost was exceedingly moderate.

Linnean Society, April 17.—Prof. S. H. Vines, F.R.S., president, in the chair.—Mr. A. C. Seward, F.R.S., read a paper by Miss S. O. Ford and himself on the anatomy of Todea, with notes on the affinity and geological history of the Osmundaceæ. The main points were :—(1) the investigation of the anatomical structure of Todea as represented by *T. barbara* and two of the filmy species, *T. superba* and *T. hymenophylloides*, with a view to a comparison with that of Osmunda ; (2) a summary of the geological history of the Osmundaceæ and Osmundaceous characters ; and (3) the question of the interpretation of the stelar structures of Osmunda and Todea.—On behalf of Mr. G. M. Thomson, of Dunedin, N Z., the Rev. T. R. R. Stebbing, F.R.S., read a paper on the New Zealand Phyllobranchiate Crustacea Macrura. This embodied a general revision of the group, with detailed descriptions and figures of several rare or imperfectly known species.

MANCHESTER.

Literary and Philosophical Society, April 29.—Mr. Charles Bailey, president, in the chair.—Mr. Frank F. Laidlaw made a communication on the peoples of Malacca. Special attention was directed to a number of savage nomadic communities, which inhabit the forest country of the interior for the most part. Owing to intermarriage between the various communities, as well as to the careless nomenclature employed in speaking of them, it is difficult to classify them in a satisfactory manner. In the northern half of the peninsula, however, these savages exhibit almost universally negrito characteristics, viz. curly (almost woolly) hair, very dark skins and moderately long skulls (mesaticephalic) ; the nose also is extremely wide and very flat. These negritos occur chiefly in Kedah, Kelantan and Perak. Considerable intermixture of negrito blood is also found in most of the southern wild tribes, whom many authorities believe to be derived from an admixture of Malay and negrito blood, but the evidence tends to show that in Perak, at least, there exists a second race quite distinct from negrito or Malay—a dolichocephalic, moderately fair-skinned race with wavy hair, and possibly allied to the Karens of Burmah. Lastly, the people of Johor, Selangor and Pahang are obviously of mongoloid stock. Like the other two groups, their stature is small (average height of a full-grown man 4ft. 6in., of a woman 4ft. 3½in.), but the hair is straight and the skull brachycephalic. It is not improbable that this latter group is largely descended from Malays who refused to adopt the creed of Islam ; or they may perhaps more probably be derived from the widely spread pro-Malay race, of which the Malays themselves and the Javanese, &c., are specialised offshoots.

DUBLIN.

Royal Dublin Society, April 16.—Prof. D. J. Cunningham, F.R.S., in the chair.—Prof. John Joly, F.R.S., read a paper entitled "A Sedimentation Mystery."—Prof. G. A. J. Cole and Mr. T. Crook exhibited a large number of stones dredged by the Irish Fishery Survey from the Porcupine Bank and other places off western Ireland. They pointed out that the stones varied from one place to another so distinctly as to give a real clue to the submarine geology of the area. The basalt-plateau of the north was not here traceable, and the rocks in general represented submerged extensions of those known upon the western coast. The Porcupine Bank includes a large boss of olivine-gabbro like some of those associated with Carboniferous rocks in England. The description of the rocks is reserved for the Fishery Reports of the Department of Agriculture and Technical Instruction for Ireland.

Royal Irish Academy, April 28.—Prof. R. Atkinson, president, in the chair.—Prof. Chas. J. Joly read a paper on quaternion integrals depending on a single quaternion variable. The method employed is given in Hamilton's lectures, and the author indicated a simple step by means of which the fundamental theorems of Green and Stokes and their quaternion extensions may be deduced from Hamilton's results. The quaternion integrals must be either single, double, triple or quadruple ; and in general the difference of two integrals of a given type taken between the same fixed limits but with different "modes of passage" is expressed as an integral involving one additional quaternion differential. Physical examples are given of the meaning of the different types of integrals, for example the conditions that the scalar double integral should be independent of the mode of passage are the well-known equations connecting the electric displacement and the magnetic force in a non-conducting dielectric.

PARIS.

Academy of Sciences, April 28.—M. Bouquet de la Grye in the chair.—The president announced to the Academy the death of M. Filhol.—Studies on batteries founded upon the reciprocal reaction of oxidising and reducing liquids. Common solvents. The action of acids on bases, by M. Berthelot.—On the treatment of malarial fevers by latent arsenic, by M. Armand Gautier. In a preliminary note published in February last, an account was given of the treatment of nine cases of malarial fever by injections of minute amounts of sodium methyl-arsenate. These results have now been extended, some twenty-three cases having been under treatment with entirely satisfactory results. All of these were severe cases which had proved refractory to the prolonged action of quinine, even in large doses. Out of ten cases of tertiary fever, four showed a slight relapse, the remaining six being completely cured by three successive injections of five to ten centigrams of the arsenical salt. In two cases of quaternary fever, the specific organism only disappeared after four or five successive injections of ·1 to ·2 gram. Detailed instructions are given for the mode of application of sodium methyl-arsenate in the various types of malarial fever.—The culture of the forage beet in the experimental field at Grignon in 1900 and 1901, by MM. P. Dehérain and C. Dupont. It has been previously shown that the beet giving the largest gross weight of roots per hectare is not necessarily the best for forage purposes. As the result of two years' experiments on the large scale, the variety known as *Géante demi-sucrière rose* was found to be decidedly superior to the old forage beet. It was also found that the mode of arranging the plants was without effect on the yield provided that the number of roots per square metre did not exceed ten.—Geographical work round the central massif of Madagascar, by M. P. Colin. The present paper is confined to geodesic and astronomical results. The magnetic observations will be given in a future paper.—On the third voyage of the *Princess Alice II.*, by S. A. S. Prince Albert of Monaco. A *résumé* of the results in oceanography, geography, zoology, physiology and bacteriology.—Report presented by the commission charged with the scientific control of the geodesic operations at the Equator, by M. H. Poincaré.—Observations of the comet A (1902) made at the Observatory of Algiers with the 0·318 cm. equatorial, by MM. Rambaud and Sy.—On divergent series and differential equations, by M. Edmond Maillet.—The measurement of high temperatures and Stefan's law, by M. Féry. A cone of rays from the body the temperature of which is to be measured is concentrated by a fluor-spar lens upon a delicate iron-constantin thermocouple. The temperatures indicated by this instrument were compared with those calculated by the law of Stefan ; the error did not exceed 1 per cent.—A universal scale of periodic movements graduated in savarts and millisavarts, by M. A. Guillemin. The author proposes a new unit in acoustics to replace the octave and the comma. The use of the new unit, the millisavart, leads to a great simplification in numerical calculations.—On the graduation of thermoelectric couples, by M. Daniel Berthelot. The couples used were of platinum in contact with 10 per cent. platinum-iridium. The temperatures of five melting points and eight boiling points were determined by two couples independently, the maximum difference between the two being about 2° C. If e be the electromotive force of a thermocouple and t the centigrade temperature, $\log e$ is a linear function of $\log t$ for temperatures between 400° and 1100° C. This relation being assumed, it is only necessary to have two standard points to calibrate a couple, and for this purpose the melting points of zinc (419°) and gold (1064°) are recommended as the most suitable. With a good galvanometer there is no difficulty in obtaining a sensibility of 0°·1 C. in the neighbourhood of 1000° C.—On the indices of refraction of liquid mixtures, by M. Edm. van Aubel. According to a recent paper by M. Leduc, the refractive energy of a mixture of alcohol and water is the sum of its constituents if the contraction of volume which takes place on mixing is taken into account. Experimental results are now given for mixtures

of acetone and water, aniline and ethyl alcohol. In the case of the first mixture, the difference between the experimental figure and that calculated according to M. Leduc's hypothesis amounts as a maximum to four units in the fourth decimal place, in the second case the deviation amounts to double this amount. The conclusion is therefore drawn that the refractive energy, $n-1/d$, is not constant in liquid mixtures within the limits of experimental error.—Variations of the temperature of the open air in the zone comprised between a height of 8 and 13 kilometres, by M. L. Teisserenc de Bort. The results of the discussion of observations carried out in 236 captive balloon experiments. These results represent all seasons of the year and cover several years.—On the manufacture of certain metallic tools by the Egyptians, by M. Albert Colson. Analysis of an ancient Egyptian bronze tool.—The composition of the hydrate of chlorine, by M. de Forcrand. By the application of the principle described in previous papers, the conclusion is drawn that the composition of chlorine hydrate is $Cl_2.7H_2O$.—On some derivatives of oxyisopropylphosphinic acid, by M. C. Marie. The mode of preparation and properties of the sodium, lead, copper and silver salts.—On the transformation of proteids in plants during germination, by M. G. André.—Observations on orogenic poles, by M. Stanislas Meunier.—Glycosuria of muscular origin; the appearance of glycuronic compounds and glycose in the urine of animals submitted to a ligature or crushing of the muscles, by MM. Cadeac and Maignon.—Does lipase exist in normal serum? by MM. Doyon and A. Morel. Hanriot has supposed that there exists in normal serum of vertebrates a soluble ferment, lipase, which possesses the power of saponifying organic esters. None of the experiments here given support this view, and the existence in normal serum of a lipase acting upon olein cannot be demonstrated.—On acute polymicrobial osteomylitis, by M. Ragalski. In a case of osteomylitis of the clavicle, both the coli bacillus and staphylococcus were found to be present in the blood from the bone.

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (physico-mathematical section), part 1 for 1902, contains the following memoirs communicated to the Society:—

January 11.—Emil Bose: on the nature of the electrical conduction in Nernst's electrolytic luminescent oxides. M. Abraham: the dynamics of the electron.

January 25.—Alfred Loewy: on reducible linear homogeneous differential equations.

February 8.—W. Voigt: contributions to the theory of pleochroic crystals. O. Wallach: researches from the University Chemical Laboratory (series x.)—(1) new syntheses in the terpene series; (2) on the separation of α- and β-methyladipinic acid; (3) on a series of new isomeric cyclic ketones of the formulæ $C_9H_{14}O$ and $C_9H_{16}O$; (4) on the formation of ε-betaines; (5) on phellandrene. C. Jacobi: contribution to the physiological action of the organic ammonium iodides and polyiodides.

DIARY OF SOCIETIES.

THURSDAY, MAY 8.

IRON AND STEEL INSTITUTE, at 10.30 a.m.

ROYAL INSTITUTION, at 3.—Recent Geological Discoveries: Dr. A. Smith Woodward, F.R.S.

SOCIETY OF ARTS (Indian Section), at 4.30.—The Past and Present Connection of England with the Persian Gulf: T. J. Bennett.

MATHEMATICAL SOCIETY, at 5.30.—On Groups in which every two Conjugate Operations are Permutable: Prof. Burnside, F.R.S.—Fermat's Theorem on Binary Powers: A. E. Western.—The Application of Contour Integration to the Solution of Problems in the Theory of Conduction of Heat, and to the Development of an Arbitrary Function in Series: Mr. H. S. Carslaw.—The Application of Fourier's Series to the Conduction of Heat: Dr. Gamesh Prasad.—Some formulæ in Elimination: Dr. F. S. Macaulay.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Form of Model General Conditions. (Conclusion of Discussion).

FRIDAY, MAY 9.

PHYSICAL SOCIETY, at 5.—A Simple Electric Micrometer. Part I.: Dr. P. E. Shaw.—The Conservation of Entropy: J. A. Erskine.—Rational Units of Electromagnetism: Sig. G. Giorgi.

COLD STORAGE AND ICE ASSOCIATION (Society of Arts), Afternoon.—The Rationale of Cooling Phenomena: Dr. W. Hampson.—The Business Side of Cold Storage: R. J. Key.

ROYAL INSTITUTION, at 9.—Exploration and Climbing in the Canadian Rocky Mountains: Prof. J. Norman Collie, F.R.S.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Jacobi's Nome (q) in Astronomical Formulæ, with Numerical Tables: R. T. A. Innes.—Series in the Nebular Spectrum, and in the Bright-line Spectrum of Nova Persei: E. F. J. Love.—The Spectrum of Nova Persei, 1901, on and after September 5: Rev. W. Sidgreaves.—Visual and Spectroscopic Observations of the Sun-spot Group of 1901 May 19–June 26: Rev. A. L. Cortie.—Reduction of Extra-Meridian Observations of Planets: P. H. Cowell.—Micrometrical Measures of Double Stars with the 17½-inch Reflector: Rev. T. E. Espin.—*Promised papers:* On the Accuracy of Photographic Measures. Second Note: H. C. Plummer.—Photographic Observations of the Satellite of Neptune: Royal Observatory, Greenwich.

MALACOLOGICAL SOCIETY, at 8.

MONDAY, MAY 12.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—On Snow-Waves and Snow-Drifts in Canada: Dr. Vaughan Cornish.

VICTORIA INSTITUTE, at 4.30.—Some Diseases mentioned in the Bible: Dr. T. Chaplin.

HAMPSTEAD SCIENTIFIC SOCIETY, at 8.30.—The Relation of Science to Art: Sir Samuel Wilks, Bart, F.R.S.

TUESDAY, MAY 13.

ROYAL INSTITUTION, at 3.—Recent Geological Discoveries: Dr. A. Smith Woodward, F.R.S.

WEDNESDAY, MAY 14.

SOCIETY OF ARTS, at 8.—Boats and Boat Building in the Malay Peninsula: H. Warington Smyth.

GEOLOGICAL SOCIETY, at 8.—On Pliocene Glacio-Fluviatile Conglomerates in Subalpine France and Switzerland: Dr. Charles S. Du Riche Preller.—Overthrusts and other Disturbances in the Radstock Series of the Somerset Coalfields: F. A. Steart.

THURSDAY, MAY 15.

ROYAL SOCIETY, at 4.30.—*Probable papers:* Microscopic Effects of Stress on Platinum: T. Andrews, F.R.S., and C. R. Andrews.—Cyanogenesis in Plants. Part II. The Great Millet, *Sorghum vulgare*: Prof. W. R. Dunstan, F.R.S., and Dr. T. A. Henry.—The Minute Structure of Metals and other Plastic Solids: G. Beilby.—On Electro-Motive Wave accompanying Mechanical Disturbance in Metal immersed in Electrolyte: Prof. J. C. Bose.—On some Phenomena affecting the Transmission of Electric Waves over the Surface of the Sea and Earth: Capt. H. B. Jackson, R.N., F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS (Society of Arts), at 8.—Electrical Traction on Steam Railways in Italy: Prof. C. A. Carus-Wilson.

CHEMICAL SOCIETY, at 8.

FRIDAY, MAY 16.

ROYAL INSTITUTION, at 9.—The Nebular Theory: Sir Robert Ball, F.R.S.

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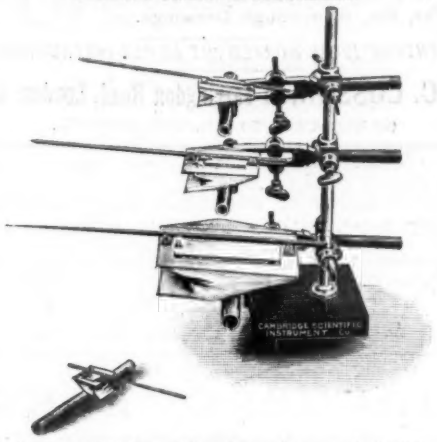

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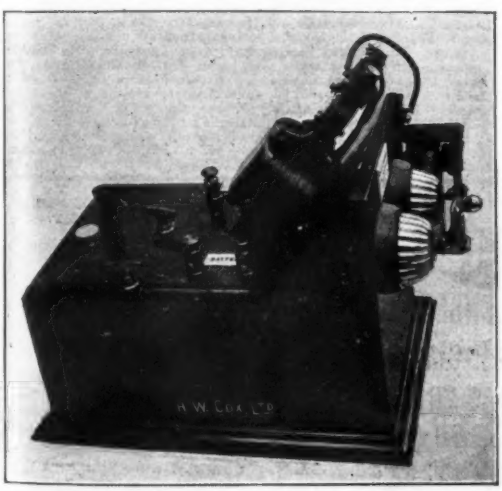

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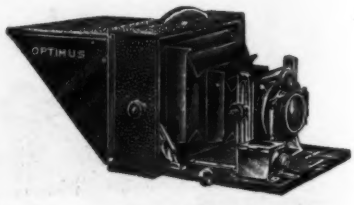

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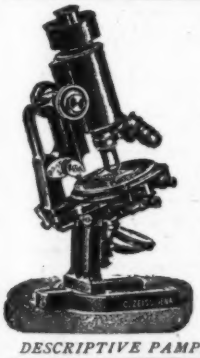

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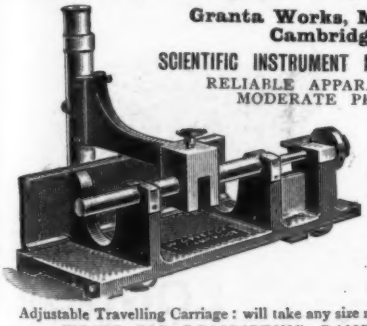

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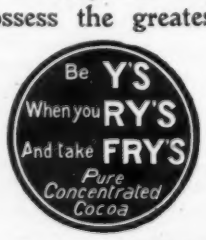

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